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CONSEIL PERMANENT INTERNATIONAL
POUR L'EXPLORATION DE LA MER
CHARLOTTENLUND SLOT – DANEMARK

JOURNAL DU CONSEIL

VOL. XV · NO. 3

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J. R. LUMBY

EN COMMISSION CHEZ
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SEPTEMBRE 1948

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Instituto Español de Oceanografía.

By

Rafael Garcia.

THE Spanish Institute of Oceanography has great pleasure in participating once again in the work of marine investigation. Difficulties arising first out of our own civil war and later on out of the world-wide conflict, have prevented the carrying out of the work intended, but nevertheless the time has been devoted to the reorganization and extension of our different departments.

This Institute again came under the control of the Ministry of Marine in 1935, experience having shown that the needs of the Institute were more sympathetically considered by this Ministry than by any other, both as regards staff and material, and work was facilitated by the provision of appropriate craft.

The Institute is now composed of four Departments or Sections: Biology, Physics, Oceanographic Chemistry, and Industrial Chemistry, these Departments forming a central nucleus in Madrid, with Direction General, Sub-Direction, and Secretary's Office.

The coastal laboratories of Palma de Mallorca, Santander, and Malaga have kept up their regional work, and a further one has been established in Vigo, the most important fishing centre of Spain.

In 1941, the new premises of the Malaga Laboratory, specially constructed for the Institute were inaugurated. Among other sections, it has a magnificent aquarium, an oceanographic museum, a library, lecture halls, general laboratories for biology, chemistry, and physics, Director's laboratory, and twelve other individual laboratories at the disposal of foreign and Spanish professors and students from faculties situated in the south of Spain who are anxious to specialize in marine science.

The old laboratory of Santander is now provided with new premises on the island of Marnay, situated in the bay, with four laboratories and oyster grounds, and the construction of a new building to replace the City's old installation is about to commence.

This new building will be provided with an aquarium, library, museum, general laboratories for biology, chemistry and physics, and

six individual laboratories in which, as in Malaga, foreign and Spanish investigators and students from the summer University "Menendez Pelayo" will find facilities for their work. It is expected that these new installations will be ready for use in a little over a year.

The Oceanographic Society of Guipuzcoa has made over to us the control of the "Sea Palace" (Palacio del Mar) in San Sebastian, where our staff will be working permanently.

With the laboratories of San Sebastian, Santander, and Vigo, the Cantabrian and north-west coast of the peninsula is adequately served.

In 1935 it was found necessary to close down the Canary Islands laboratory, owing to insuitable premises and scarcity of staff; but local

Fig. 1. Málaga: External view of the Laboratory.

organizations, realising the international importance of its geographical situation, are now offering to construct a new building on a splendid site.

In Palma de Mallorca too it is proposed to extend the premises, despite the fact that with the existing installation the most pressing needs of that region are covered and space is sufficient to allow of the continuance of the laboratory's traditional and useful hospitality to foreign investigators.

Despite the difficulties to which allusion has already been made, two investigations were carried out in 1941; one in Vigo in August, with a fishing and fishery-control vessel, the V. 12, and one on the coast of the Sahara in May and June, on which the deep-sea fishing vessel "Abrego", belonging to the Company "Pesquerías y Secaderos de Bacalao de España", was employed.

In 1942, further work was carried out in the same region, in the months of July to September, with the motor fishing vessel, "Cierzo"

of the same concern, and on the coasts of the Balearic Islands and the Columbretes, with the vessel V. 14.

During August 1943, work was carried out in the bay of Palma, with the assistance of the small craft belonging to the Institute.

Further work was undertaken in August 1945, with the fishery-control boats V. 8 and V. 12, and finally, in May and June of the present year, more work has been done on the coasts of Morocco and the Sahara, with the assistance of the hydrographic vessel "Malaspina" and the patrol boat "Xauen".

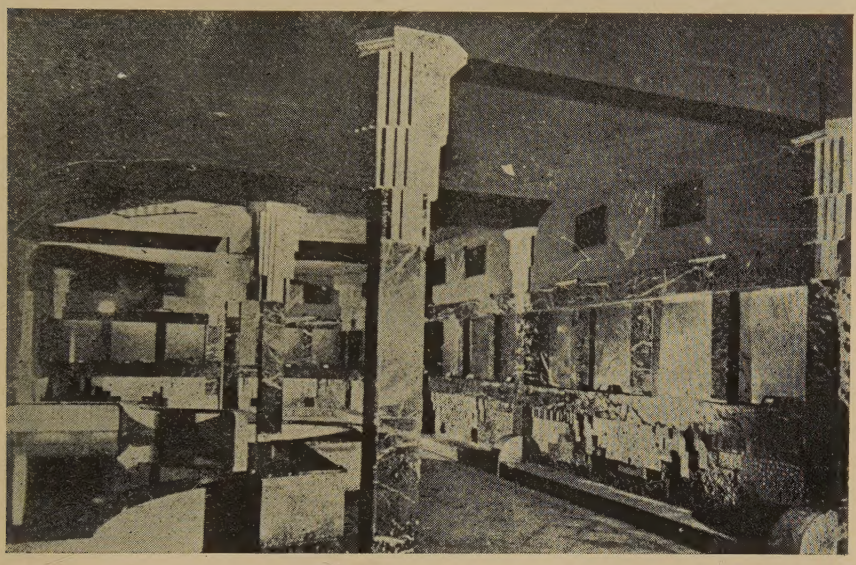


Fig. 2. Málaga: Aquarium.

The work in the estuary of Vigo, was undertaken with the object of investigating the sea-bottom, constructing a chart of edible mollusc beds in those waters, with a summary of the species found, studying the ecology of the principal species and the biocenosis of the beds, as well as the means of exploitation and details of reproduction.

The preserves, breeding, and fattening grounds were also visited and their cleanliness inspected. The causes of their exhaustion were deduced and remedies proposed.

The chief object of the work carried out on the coasts of the Sahara in 1941 and 1942, was to ascertain whether our boats — should they be unable to visit the cod grounds of Newfoundland and Greenland — could find a good substitute in the species of fish caught in the shallow waters of Cabo Blanco and Banco Arguin. The most suitable processes of preparation and salting were studied and the most outstanding defects were noted, and their remedies suggested. The best kinds of fish for preserving were also noted. At the same time, studies on

meteorology, hydrography and oceanography, geology and morphology of the coast, the fauna, etc., of its waters, were made.

In the summer of 1942, our Institute collaborated with the Direction General of Fishing in an investigation intended to elucidate certain problems of a biological nature connected with the sardine and the fishing industry in the Columbretes and Balearic Islands, with highly interesting results.

During the work carried out in Palma de Mallorca in 1943, the

Fig. 3. Málaga: A Laboratory.

physical and chemical conditions of the bay and of the region southwest of Mallorca were investigated, with the object of explaining the seiches, the study of which had been begun before 1936.

In the summer of 1945, a study was made of the general outlines of the problems relating to the biology and cleanliness of the oyster beds, and in May and June, on the African coast between Agadir and Cabo Juby, a bathymetric and lithological map was drawn up with sufficient accuracy down to the level of 500 m. to determine the physico-chemical conditions of the water and marine life, this being a preliminary study for the construction of a fishery chart for the region.

The following reports of these investigations have been published:—

1942.— "Bibliografía para un catálogo de la Fauna y Flora del Mar de Baleares", por Francisco de P. Navarro.

"Estudio de los yacimientos de moluscos comestibles de la Ría de Vigo", por Jose Mª Navaz.

1943.— "Estudio químico sobre los pescados españoles" por Jose Cerezo y Antonio Rodriguez de las Heras.

1944.— "La pesca de arrastre en los fondos de Cabo Blanco y del Banco de Arguín (Africa Sahariana)", por Francisco de P. Navarro, Fernando Lozano Cabo, Jose Mª Navaz y Jose Sainz Pardo.

"Estudio Bio-estadístico del Esturión o Sollo del Guadalquivir", por I. E. A. Classen.

"Notas y Resúmenes"

1935.— "Adición a las notas sobre "algunos equinodermos de Groenlandia", por Victoriano Rivera Gallo.

"Fauna ictiológica. Catálogo de los peces ibéricos: de la planicie continental, aguas dulces pelágicas y de los abismos próximos", por Fernando de Buen.

"Nuevos datos sobre la continua variación de la temperatura de las aguas submarinas en la bahía de Palma de Mallorca", por Francisco de P. Navarro.

"Caracteres oceanográficos del Estrecho de Gibraltar en 1934" (Campañas del "Xauen"), por Rafael de Buen.

1936.— "Nota sobre la determinación de las proteinas del suero sanguíneo y variaciones de la razón (serina, globulina) en el de algunos peces, por cambios y salinidad", por O. Gomez Ibañez.

"Análisis de la variación térmica en el agua de la bahía de Palma de Mallorca", por Francesco Vercelli.

"La refractometría en el agua de mar de salinidad elevada", por O. Gomez Ibañez.

1940.— "Foraminiferos de las costas Vascas y de la Ría de Marín", por G. Colom.

"Composición y ciclo anual del plancton superficial de la bahía de Palma de Mallorca", por F. de P. Navarro y M. Massuti.

"Sobre el estado actual de nuestro conocimiento de la Fauna y Flora del Mar de Baleares", por F. de P. Navarro.

"Los Copépodos pelágicos del Mar de Baleares", por Miguel Massuti.

"Dos cartas inéditas de los botánicos Cabrera y Lagasca sobre algas españolas", por Luis Bellon.

"Tintínidos fósiles (infusorios oligótricos)", por G. Colom.

"Nota sobre un herbario de Algas de Málaga, de don Simon de Rojas Clemente y Rubio", por Luis Bellon.

"Datos para la fauna carcinológica de España: Decápodos marinos de Vigo", por Alvaro de Miranda.

1941.— "Resultados de una campaña oceanográfica verificada en la ría de Vigo durante el mes de Agosto de 1941, bajo la dirección del Jefe del Departamento de Quimica Aplicada, D. Ricardo Montequi. Investigaciones quimicas y determinaciones de algunas constantes físicas", por Mª Jesus del Val y Enrique Otero.

"Constitución de los aceites de animales marinos", por Enrique Otero.

"Algunos problemas de la Oceanografía en España", por Jesus Mª de Rotaeche.

1942.— "Nota preliminar sobre los peces de la costa de Africa, desde el Cabo de Bojador a la bahía de Tanit (Resultados de una campaña industrial de pesca de arrastre)", por Francisco de P. Navarro.

"Una contribución al conocimiento de los Foraminíferos de la bahía de Palma de Mallorca", por G. Colom.

"Notas fenológicas sobre los Copépodos pelágicos de la bahía de Palma de Mallorca", por Miguel Massuti.

"Las algas de la "Flora Boetica", inédita de Clemente", por Luis Bellon.

"Crítica de los principales métodos para la determinacíon del índice de yodo en las grasas", por R. Montequi y A. Doadrio.

1943.— "Influencia del contenido graso de las especies en la salazón del pescado", por Enrique Otero y Mª Jesus del Val.
"Toponimia de los fondos del Cantábrico (Apuntes para la carta de pesca)", por J. Cuesta Urcelay.
"Notas sobre otolitos de peces procedentes de las costas del Sahara"; primera parte: Fam. *Sparidae*", por Josefa Sanz Echevarria.
"Estudios acerca de algunos aceites de animales marinos", por Enrique Otero Aenlle.

1944.— "Operaciones oceanográficas en la bahía de Palma de Mallorca (1932—1934)", por Francisco de P. Navarro.
"Algunos aspectos y problemas de la Oceanografía moderna", Conferencia por Jesus Mª de Rotaeche.
"Contribución a la Biometría de la Sardina de España, *Sardina pilchardus* (Walb.)", por Francisco de P. Navarro.
"Acción de diversos secadores, artificiales en la oxidación y secado del aceite de sardina" por E. Otero Aenlle y Mª Dolores Garcia Pineda.
"El aceite de sardina en la preparación de aceites yodados", por R. Montequi y A. Doadrio.
"La determinación rápida de humedad y grasa de pescado", por Mª Jesus del Val.
"El índice de polibromuro en las grasa, su determinación e importancia, cálculo de los ácidos altamente no saturados", por E. Otero Aenlle y Mª de los Dolores Garcia Pineda.

1945.— "Nota sobre algunas fases del desarrollo embrionaria de la musola *Mustelus mustelus* (L.)", por Fernando Lozano Cabo.
"Catálogo de la Flora del Mar de Baleares" (Con exclusión de Diatomeas) por Francisco de P. Navarro y Luis Bellon Uriarte.
"Anteproyecto de nuevos tipos de correntímetros marinos", por Luis Lozano Rey.
"Contribución al estudio de la valoración de la vitamina "A", por F. Poggio y Maria Martin Retortillo.
"Estudio analítico del aceite de bonito (*Germo alalunga*). I. Constantes físico-químicas", por E. Otero Aenlle y A. de la Fragua.
"Estudio del Electrodo de antimonio para la medida del pH en el agua del mar", por Jesus Aravio-Torre.
"Nota sobre la presencia de los estados juveniles de *Luvarus imperialis* Rafinesque, en las costas de Baleares y Cataluña", por Fernando Lozano Cabo.

1946.— "Aplicación de la espectrografía de absorción en el U. V. al estudio de aceites", por F. Poggio y M. Martin Retortillo.
"Nuevos datos sobre la substitución alternativa en la pesca de peces emigrantes en el litoral de Galicia", por Jose Mª Navaz.
"Sobre algunos peces poco frecuentes o desconocidos en las costas de Galicia", por Jose Mª Navaz y Sanz.
"Apuntes para la Biología y Biometría de la Sardina, Anchoa, Boga y Chicharro de las Costas Vascas", por Francisco de P. Navarro y Jose Mª Navaz.

In the press:—

Estudio de la dureza de los films de aceite de sardina", por Enrique Otero Aenlle y Mª Dolores Garcia Pineda.
"Determinación del pH en el agua del mar", por Jesus Aravio-Torre..
"Proyecto de una campaña oceanográfica en el Estrecho de Gibraltar", por Nicanor Menendez.
"Corrosión de metales en contacto con el agua del mar", por Emilio Jimeno.

We have to lament the death of our Founder and first Director, Professor Odon de Buen y del Cos, and also that of our Assistant Professor and Professor of Chemistry of the University of Valladolid, Mr. José Cerezo Gimenez.

In 1943 hydrography, formerly dealt with by a section of the Institute and Astronomical Observatory of Marine in San Fernando (Cádiz), was allotted to an independent organization, with the name of "Instituto Hidrográfico de la Marina". This body was installed in a new building in the bay of Cádiz near the port, and has been working on the preparation of new nautical charts of the region south-west of the peninsula and east of African waters, using the hydrographic vessel

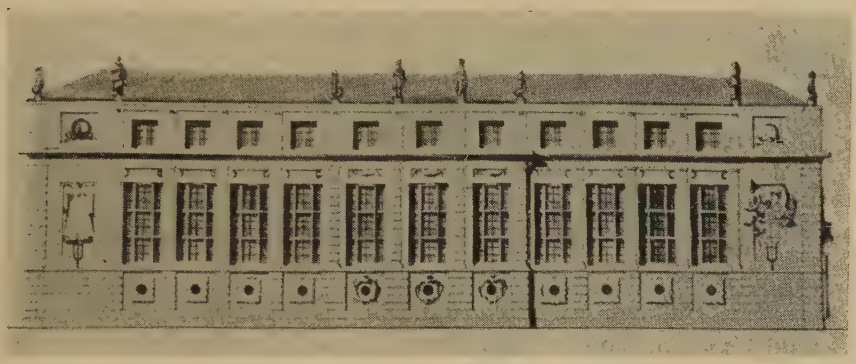


Fig. 4. Santander: Design for laboratory.

"Malaspina". By the end of the year this Institute will have at its disposal the vessel "Tofiño", of the same type, and the "Artabro". The latter will be sent to Fernando Póo and Guinea. The Oceanographic Institute will work in collaboration with the Hydrographical Institute on the construction of fishery charts in those regions in which the former institute has already commenced hydrographical work, namely on the coast of the Sahara where work was begun in May and June.

For the study of tides, mareographs have been installed at Santander, Gijón, Coruña, Vigo, Huelva, Cádiz, Ceuta, and Málaga, and those for Alborán, Puerto de la Luz (Canary Islands), Arrecife (Canary Islands), and San Sebastián are awaiting installation. The former have been working since 1944, and the latter will begin to work in 1947.

We hope that next year when new boats will be completed for coast and fishery control, the Ministry of Marine will be able to place at the disposal of the Institute the "Xauen" and some other similar vessel, which, with one on the Cantabrian coast and the other in the Golfo de España and Straits of Gibraltar, will enable us to proceed satisfactorily with the work that has been entrusted to us, not only in the interests of our own country, but in those of other lands, and that we shall all be able to enjoy the benefits of world peace.

Recherches préliminaires sur la fertilité marine au large d'Alger.

Par

Francis Bernard,

Université d'Alger.

LES côtes d'Algérie ont un intérêt particulier pour la biologie du plancton, étant longées par le courant fertile d'origine atlantique venu de Gibraltar. Ce courant, presque permanent, mais variable de largeur et de profondeur, passe à quelques milles au nord de la baie d'Alger. D'après les résultats hydrographiques des expéditions danoises (J. N. Nielsen, 1912, et ses successeurs) sa présence est perceptible jusqu'à 200 à 300 mètres de profondeur, d'après les diminutions de température et de salinité par rapport aux eaux méditerranéennes pures du centre de la mer.

Le but des recherches entreprises par nous depuis 1942 est de préciser les limites horizontales et verticales de ce courant, et surtout leurs variations saisonnières durant plusieurs années, en fonction des vents locaux. Ces données initiales seront indispensables pour analyser la biologie du plancton, si dépendante des agents physiques.

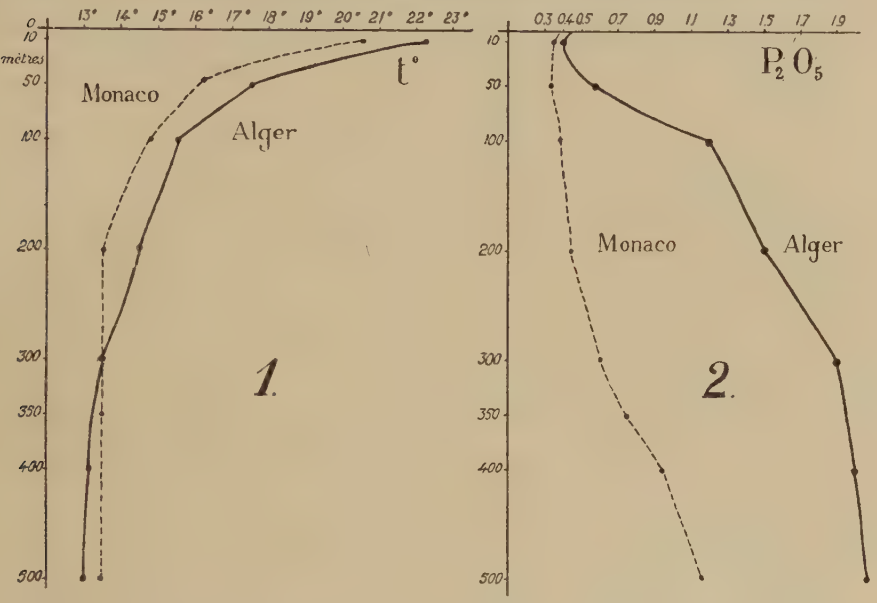
Par suite des difficultés matérielles du temps de guerre, les opérations au large se sont, jusqu'à présent, limité à quelques périodes: 20. Mai au 27. Octobre 1942; quelques prises d'eau en 1945—46; prises plus régulières en 1947, de 10 à 500 mètres de profondeur. Les grands fonds commencent près d'Alger; nos stations les plus courantes sont au NNE. de la ville, la station C à 6 km. du port, par 500 mètres de fond, la station D à 10 km., par 1,350 m. Les faits exposés ci-dessous représentent donc la moyenne de mesures assez peu nombreuses, 400 prises d'eau environ, jusqu'en Septembre 1947; il s'en dégage déjà plusieurs indications fructueuses sur la distribution verticale des sels nutritifs et du microplancton. L'étude détaillée du macroplancton et de l'action du climat complétera plus tard ces travaux.

Technique.

L'eau de mer est prise par bouteilles Richard de un litre, aux niveaux de 10, 50, 100, 200, 250, 300, et 400 mètres (stations C et D), une fois par mois durant 14 mois. Vu l'espacement des sorties, on utilisera surtout les moyennes de toutes ces données, pour avoir un schéma d'ensemble des variations de fertilité dans le sens vertical, et les comparer aux gradients verticaux obtenus au large de Monaco, de 1937 à 1939. De temps en temps (cinq fois en tout) l'eau des couches à 500 et 750

mètres a été prise en D. Enfin, par bouteille de 10 litres, quelques prélèvements à 50, 100, et 400 mètres ont permis d'examiner plus en détail le peuplement en Flagellés calcaires.

Les **températures** sont mesurées grâce à un thermomètre Richter à renversement, et corrigées au moyen du tableau d'étalonnage de cet instrument. Le graphique 1 donne la moyenne des résultats de Mai à Octobre



Graphique 1. Répartition verticale moyenne des températures pour la période du 20. Mai au 20. Octobre (15 à 20 prises d'eau à chaque niveau. En abscisse températures en degrés centigrades. En ordonnée, profondeurs en mètres, à Alger 1942 (traits pleins) et Monaco 1938 (traits interrompus). On notera l'inversion vers 300 mètres. Graphique 2. Répartition verticale moyenne des phosphates dissous (en mg. P_2O_5 par mètre cube). Le reste comme sur le graphique 1.

1942: par rapport à la période correspondante de 1938 à Monaco, on notera l'inversion vers 300 m.: au dessous de ce niveau, la mer est plus froide à Alger. Signalons ici que le maximum de température en surface est de 25—26° à Monaco (fin Juillet), et seulement de 22—23° à Alger (fin Août): l'influence des eaux atlantiques paraît ici manifeste.

L'**oxygène** n'a été dosé que de Mars à Octobre 1947 (méthode de Winkler): les résultats obtenus par M. Cachon démontrent déjà l'existence d'une couche à minimum d'oxygène vers 250 mètres (60 à 71 % de la saturation, au lieu de 73 à 80 % plus bas).

Les **phosphates** dissous furent évalués colorimètriquement, par la méthode Denigès-Atkins au molybdate d'ammoniaque: leur taux varie de 0·3 à 10 mg. par mètre cube; il tombe rarement à zéro au large.

Les **nitrates** sont aussi dosés colorimètriquement, grâce à la strychnine réduite, depuis Janvier 1947 seulement; comme à Monaco, ils semblent limiter beaucoup moins que les phosphates la production de phytoplancton.

Le **nanoplancton** est compté au microscope inversé, dans des vases de 14 cc. d'eau fixée au formol neutre à 4 %. Le détail de la méthode est précisé dans une publication antérieure (F. Bernard, 1938). En plus du nombre de cellules par litre (Flagellés, Diatomées, Infusoires, Schizophytes), leur volume total est évalué d'après la dimension habituelle des espèces dominantes: parmi celles-ci, *Coccolithus fragilis* joue le principal rôle quantitatif. Le total des divers stades de ce Flagellé calcaire (spores, kystes, palmellas, et phases typiques) peut dépasser 3 millions par litre et représente alors plus d'un milligramme de substance vivante.

1. Variations des sels nutritifs.

Les **phosphates** (graphique 2), augmentent en profondeur bien plus fortement qu'à Monaco (2 mg. P_2O_5 en moyenne à 300 mètres, contre 0·5 à Monaco). Leur taux s'accroît légèrement depuis le port d'Alger jusqu'à la station D (5·5 milles au NNE. du port), bien que le phytoplancton du large soit en moyenne plus dense: nouvel indice que les réserves viennent des grandes profondeurs et non de la côte.

Le maximum annuel (7 à 10 mg., de 0 à 500 m.) apparaît en Avril—Mai, et non en Février—Mars comme à Monaco et Banyuls. Pourtant, le réchauffement printanier des eaux est tout aussi précoce à Alger que dans le nord de la Méditerranée, mais le cycle du phosphore paraît suivre ici le type atlantique. Les minima sont de 0 mg. en surface (0 à 50 m), de 0·5 à 1 mg. plus bas. Il y a en moyenne trois fois plus de phosphates disponibles qu'à Monaco.

L'accroissement des phosphates avec la profondeur est régulier, et de l'ordre de celui trouvé en été par Thomsen (1931) plus au large de l'Algérie. Par contre, les valeurs obtenues pour les **nitrates**, durant les huit premiers mois de 1947, sont surprenantes: on n'en dira que peu de mots. Il y a de 0 à 450 mg. de N_2 nitrique par mètre cube, avec maximum vers 250 à 300 mètres de profondeur; plus bas, le taux diminue et rejoint vers 750 mètres celui de surface (90 mg. en moyenne, contre 150 à 200 à 300 m.). De plus, les variations mensuelles des nitrates sont considérables, et presque toujours en sens inverse de celles des phosphates. Plus encore qu'à Monaco, il y a ici des anomalies du cycle de l'azote par rapport aux phénomènes classiques des océans. Deux explications peuvent en être proposées:—

1. Entre 250 et 300 mètres se situe la couche limite entre les eaux fertiles, partiellement atlantiques, et les eaux profondes pauvres, purement méditerranéennes. Dans cette couche, dense et pauvre en oxygène, une bonne partie des cadavres doivent se décomposer, d'où maximum de nitrates;

2. A Monaco, le régime des pluies semble avoir une influence capitale sur l'azote nitrique marin: les torrents locaux lavent brusquement les terres et en apportent les nitrates au rivage. Rien de surpenant à voir des changements plus accentués encore à Alger, où les pluies sont plus intenses et encore plus irrégulières.

Quant aux différences entre le cycle des phosphates et celui des

nitrates, elles n'ont rien d'étonnant depuis que les auteurs américains (1935—38) en ont précisé les conditions. La libération des phosphates à partir des cadavres réclame une mer froide et agitée; celle des nitrates est avantagée par des eaux calmes et chaudes.

2. Composition et variations du nanoplancton.

Le terme de "nanoplancton", à défaut de mot plus précis, désignera ici l'ensemble des êtres, Unicellulaires ou Schizophytes, comptables au microscope inversé (Flagellés, Diatomées, Infusoires, et Cyanophycées de taille supérieure à 2 μ). La qualification de "protistoplancton" serait donc plus exacte, mais en l'absence de Schizophytes. Ces derniers se présentent, dans les eaux d'Alger, comme des éléments sphériques, incolores ou faiblement jaune-verdâtre, de 2 à 10 μ de diamètre, souvent groupés en chaînes. Ils manquent souvent, font rarement plus de 10 % du nanoplancton total, et pullulent surtout dans les couches moyennes (200 à 400 m.), après des maxima planctoniques: la richesse de l'eau en détritus organiques paraît les favoriser.

Chez les vrais Protistes, les Infusoires et Diatomées sont encore plus subordonnés qu'à Monaco. Même en surface, les Diatomées font rarement plus de 3 % du volume de nanoplancton par litre; *Schröderella schröderi* est la forme la plus commune en hiver à tous niveaux.

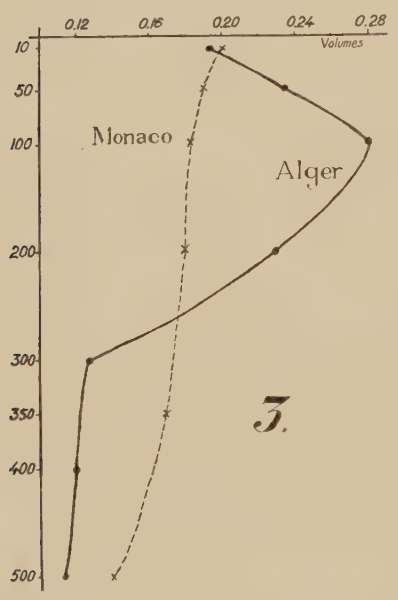
Les Dinoflagellés abondent en eaux éclairées (0 à 300 m.), principalement l'été, sauf pour les *Exuviella* qui sont communes et pérennes. Leur ensemble donne généralement moins de 20 % du volume total. Il en est de même pour les petits Flagellés nus (Cryptomonadines et Chlamydomonadines), nombreux mais représentant une masse vivante assez faible.

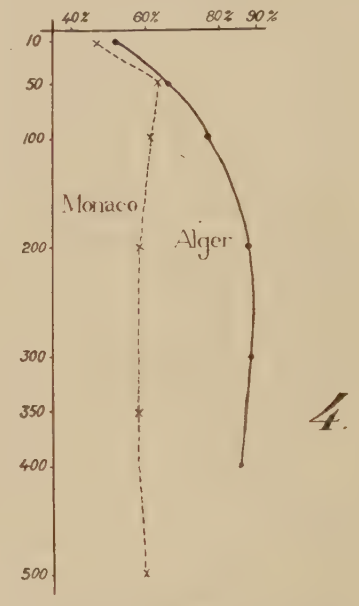
Le restriction des précédents groupes n'est pas toujours dûe à un milieu défavorable à eux, mais plutôt à des conditions favorisant le pullulement des Coccolithophorides. Le pH élevé méditerranéen, les fortes teneurs en sels et en oxygène (70 à 105 % de la saturation), amènent une prépondérance quasi-permanente de ces Flagellés calcaires. Le graphique 4 schématise leur pourcentage en volume dans les couches explorées: alors qu'à Monaco ce pourcentage moyen ne dépasse guère 60 %, il est à Alger supérieur à ce chiffre, et même voisin de 88 % à partir de 200 mètres. L'essentiel de cette production est fait par *Coccolithus fragilis* Lohm., à côté duquel on peut citer des espèces moins pérennes mais parfois dominantes quantitativement:—

Corisphaera fagei Bernard et *C. perennis* Schlauder sont communs à tous niveaux; *Syracosphaera aperta* Schlauder et *S. uninodata* Schlauder plutôt dans les couches moyennes (50 à 300 m.); *S. corii* et *S. heimii* de 300 à 750 m. L'identité de ces deux dernières formes avec les types atlantiques de Lohmann est encore incertaine.

Les travaux en cours préciseront la biologie de ces Flagellés, si importante pour la fertilité des mers chaudes. Des cultures de *Corisphaera perennis* ont été obtenues à Alger, mais l'espèce *Coccolithus fragilis*, bien plus abondante, a résisté jusqu'ici à tout essai d'élevage.

Le volume global de nanoplancton suit donc pratiquement les fluctuations de densité des Flagellés calcaires, à l'exception de quelques semaines d'été où les autres Flagellés l'emportent. Comme pour les mers tropicales, l'étendue de ces fluctuations quantitatives est relativement faible. A Monaco, le rapport du volume maximum observé (hiver) au volume minimum annuel (fin Juin) se tient entre 5 et 22 suivant les couches. A Alger, il varie entre 2 et 10, sauf à 200 et 250 m. où il





Graphique 3. Répartition verticale moyenne de la fertilité en Protistes. En abscisse, volume total du nanoplancton par litre (Péridiniens compris), évalué en millimètres cubes. Le reste comme sur le graphique 1.

Graphique 4. Pourcentage moyen en volume des Flagellés calcaires dans le total du nanoplancton. Le reste comme sur le graphique 1.

peut atteindre 40. Cette anomalie semble attribuable au fait qu'il s'agit d'une couche limite, occupée tantôt par les eaux fertiles de surface, tantôt par les eaux profondes purement méditerranéennes, beaucoup plus pauvres. Le graphique 3 représente le gradient de décroissance verticale du volume de Protistes (moyenne de Mai à Septembre), qui apparaît très différent selon les régions:

A Monaco (traits interrompus), la décroissance est faible et progressive, de 0·2 millimètres cubes en surface à 0·15 vers 500 m. (par litre). A Alger, on passe de 0·19 en surface à 0·28 à 100 m. (maximum) et 0·11 à 500 m. La grande productivité des couches moyennes éclairées, entre 50 et 200 mètres, est ici un fait constant, et les données physico-chimiques recueillies déjà ne permettent guère de l'expliquer. L'étude de l'éclairement et de la quantité d'animaux fera peut-être progresser cette question. A 300 mètres, le nanoplancton est généralement deux

fois moins dense qu'à 200: on arrive en dessous du courant fertile atlantique, et sans doute aussi dans la zone sans synthèses chlorophylliennes.

En résumé, le nanoplancton au large d'Alger est remarquable par trois faits: large dominance des Flagellés calcaires, faibles variations quantitatives saisonnières, fertilité maximum dans les couches éclairées profondes (50 à 200 m.). Celà rappelle les conditions tropicales dans les océans, mais ceux-ci sont moins transparents que la Méditerranée, d'où faible épaisseur de la couche productive éclairée.

3. Utilisation des sels nutritifs par le phytoplancton.

Si l'on met en parallèle les chiffres obtenus pour les phosphates et nitrates avec ceux qui expriment le volume des Protistes par litre, on observe, entre Monaco et Alger, des différences encore plus frappantes. Tout d'abord, la production de Flagellés autotrophes est surtout freinée par les phosphates, à Alger plus encore qu'à Monaco. A 10 et 50 mètres, ils tombent à zéro ou à des valeurs très faibles (inférieures à 0·5 mg. par tonne d'eau) six ou sept semaines par an, tandis que l'azote nitrique des mêmes couches ne s'abaisse que deux ou trois fois au dessous de 40 mg. et semble très rarement nul. Celà tient, fort probablement, à ce que l'azote provient de deux sources: apports continentaux et décomposition des cadavres, tandis que le phosphore, issu des cadavres et des couches profondes, est très peu renouvelé par les eaux douces.

A 100 et 200 mètres, la densité de phytoplancton est maximum, et sa vie autotrophe est très vraisemblable, au moins durant les journées ensoleillées au large, le brouillard côtier, si fréquent près d'Alger, devant arrêter les radiations bleues les plus pénétrantes. Ce brouillard est peut-être un des responsables de la pauvreté du phytoplancton profond aux stations A, B, C (un à 6 kilomètres du port) par rapport à la station D plus ensoleillée (10 kilomètres du rivage).

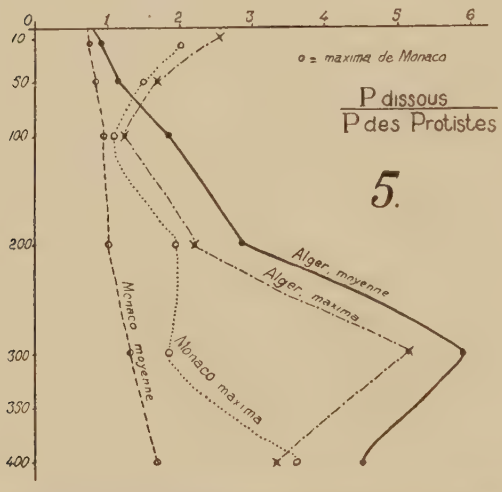
Malgré cette richesse en Protistes chlorophylliens vers 100 mètres, la couche est suffisamment voisine des eaux profondes pour que le taux des phosphates n'y tombe jamais à zéro: il peut atteindre 8 mg. et ne s'abaisse pas au dessous de 0·5. A 300 mètres et plus bas, il dépasse toujours un milligramme.

On ignore la teneur en phosphore des Flagellés calcaires, êtres dominants à ces niveaux. Des prises de 50 litres d'eau, riches en *Coccolithus*, sont actuellement mises à sédimenter, ce qui permettra plus tard des dosages chimiques sur ce stock. Toutefois, il semble intéressant dès maintenant d'évaluer, très approximativement, la quantité de phosphore contenue dans le nanoplancton et de la comparer à celle des phosphates dissous (graphique 5).

Je me baserai sur le phosphore dosé dans les Péridiniens par V i n o g r a d o v (1935—37): il trouve que ce phosphore représente en moyenne 1·7 % du carbone, contre 2·7 % chez les Diatomées. Approximativement, on admettra une teneur de P/C = 2 % dans le phytoplancton

total. D'autre part, les données moyennes du traité de Sverdrup, Johnson, et Fleming (1946) montrent que le plancton frais a une teneur en eau de 93·7 % et en carbone de 2·7 %. Avec le rapport P/C ci-dessus, on obtient 1/1,520 pour le taux de phosphore du phytoplancton vivant.

Le graphique 5 donne, par mètre cube d'eau, le rapport du phosphore des phosphates dissous au phosphore du phytoplancton, le volume de ce dernier étant évalué au microscope inversé et sa densité supposée égale à un. Les chiffres obtenus représentent en somme une "fertilité potentielle": si l'on suppose les nitrates et la lumière en quantité suffisante (cas général à Alger et Monaco), la multiplication des Protistes



Graphique 5. Fertilité potentielle à Monaco et Alger, évaluée d'après les phosphates libres et le nanoplancton. En abscisse, rapport du phosphore contenu dans les phosphates dissous à celui du nanoplancton présent (supposé égal à 1/1,520 de la masse du nanoplancton frais). A gauche, courbes pour Monaco 1938 (moyenne Mai — Octobre et maxima annuels). A droite, courbes pour Alger 1942. Ordonnées comme sur le graphique 1.

autotrophes présents va dépendre surtout du phosphore utilisable, et leur volume pourra doubler si la fertilité potentielle est égale à un. Cette valeur est largement réalisée à Alger, tandis qu'à Monaco elle se tient au dessous de un jusqu'à 200 mètres, niveau où l'éclairement ne suffit pas toujours à la fonction chlorophyllienne.

Celà concerne les taux moyens de phosphates et de plancton pour la période Mai—Octobre, seule étudiée en détail à Alger. Si l'on considère à présent les maxima (poussées extrêmes annuelles du stock biologique et des sels nutritifs), on trouve sensiblement les mêmes proportions entre phosphore libre et phosphore protoplasmique, avec avantage encore plus marqué en faveur d'Alger.

En conclusion de cette étude préliminaire, il est permis de dire que, à Monaco et Alger, la vie autotrophe est possible jusqu'à 250 mètres de profondeur, au moins en période de transparence et éclairement favorable des eaux moyennes. Les variations des sels nutritifs semblent démontrer leur emploi par le phytoplancton jusqu'à ce niveau. La fertilité statique (nombre de cellules dans chaque prise d'eau) n'est pas beaucoup plus grande à Alger, sauf précisément de 50 à 250 mètres, où elle est souvent triple de celle de Monaco. Mais la fertilité potentielle

(phosphore libre disponible pour le phytoplancton) dépasse beaucoup celle de Monaco. Il est donc possible que la cadence des mitoses de Protistes (où les palmellas de *Coccolithus fragilis* dominent habituellement) soit plus brève à Alger, d'où production réelle de matière vivante très accrue.

La densité des poissons du large (sardines, caranx, etc.) paraît quatre ou cinq fois plus grande en Algérie que sur la côte d'Azur: à la base de cette production doit exister une richesse particulière du plancton microscopique. De futures recherches sur la salinité, l'éclairement, et le macroplancton préciseront sans doute les facteurs de cette fertilité algérienne, et notamment le remarquable maximum de nanoplancton entre 50 et 250 mètres.

Résumé.

Over about a year, samples were taken of the coastal waters of the Mediterranean, 1 to 5 miles off Algiers. The preliminary examination gives some information on the current coming from Gibraltar, and on the vertical distribution of nanoplancton and nutrient salts.

The study of temperature, oxygen, nitrates, and plankton reveals an intermediate layer, at depths from 200 to 300 metres, between the surface Atlantic current and the purely Mediterranean deep water. In this layer, the quantitative annual variation of nanoplancton (in volume per litre) is in the proportion 1 to 20. In the upper and lower layers, the variation is weak, 1 to 5 in general, as is the case in warm seas.

The calcioflagellates, of which *Coccolithus fragilis* is the prevailing form, make up more than 88 % of the mean nanoplancton, instead of 50—60 % at Monaco. The volume of nanoplancton is somewhat greater than at Monaco for the same period. The phosphates are three times greater, and their amount is sufficient to assure a high "potential fertility", with a maximum of protists in the 50—250 m. layer. Autotrophic life is probably possible in these depths, and nutrient salts are consumed.

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The Quantitative Distribution of Eggs and Larvae of *Clupea sprattus* L., *Gadus morrhua* L., and *Onos cimbrius* L. in the Gulf of Gdansk in 1938, 1946, and 1947.

By

W. Mankowski.

THE material used as the basis of this paper was collected at different seasons of the three years 1938, 1946, and 1947. The periods were, in 1938, from the middle of May to the end of July; in 1946, from the middle of June to the end of July; and in 1947, from the beginning of April to the middle of November.

Chart 1 shows the distribution of the plankton stations in the Gulf of Gdansk in 1947. The distribution of stations in 1938 and 1946 was similar.

The plankton samples were taken by means of the Hensen net. At every station three vertical hauls were made from a depth of 3 m. above the bottom to the surface. The tables give the numbers of eggs and larvae under 1 m^2. of surface.

1. *Clupea sprattus* L.

Table 1 presents the observed occurrences of sprat eggs and larvae in 1938, 1946, and 1947.

During the whole period in which investigations were made in 1938, only 11 eggs and no larvae were caught.

In 1946, during the six weeks of investigation, 1268 eggs and 277 larvae were taken at 14 stations. At the beginning of the investigations the sprat had already begun spawning. Over the period as a whole, a gradual increase in the intensity of spawning could be noticed, which reached its peak at the beginning of July, with the maximum amounting to 246 eggs and 83 larvae under 1 m^2. of surface at station G_1. Considerable spawning was also observed in the middle of July, with the maximum at station G_2, where there were 230 eggs under 1 m^2. of surface. At the end of July the number of eggs decreased.

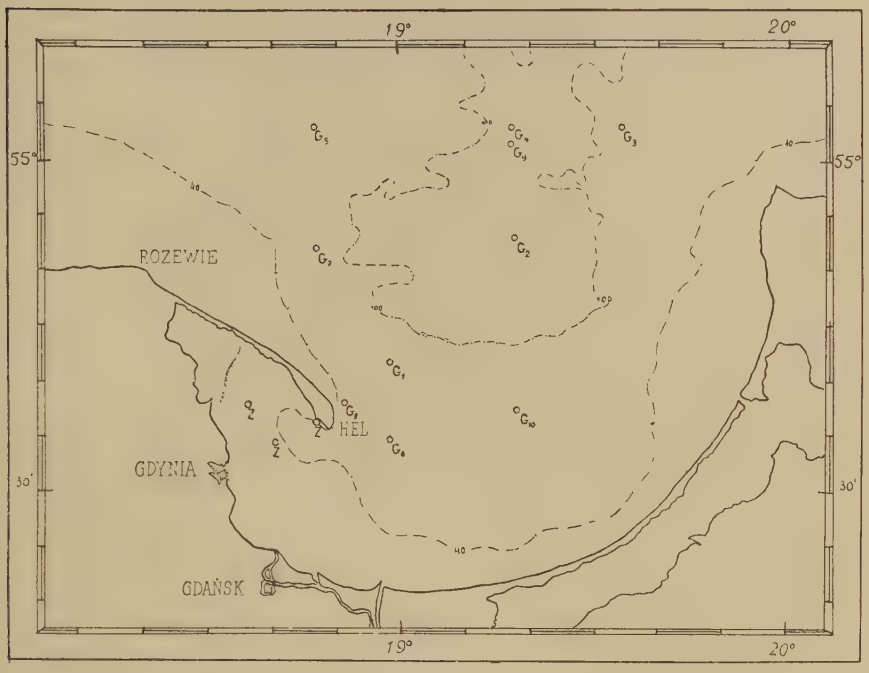

Chart 1. Distribution of plankton stations in Gulf of Gdansk in 1947.

From Table 1 it can be seen that in 1946 the location of the greatest density of eggs was not the same during the whole spawning period. In the beginning of July it was in the neighbourhood of the Hel Peninsula, while two weeks later it was found to be in the middle of Gdansk Deep.

In 1947, during the three months in which observations were made, 1262 eggs and 30 larvae were taken, at 21 stations. The intensity of spawning as estimated by the number of eggs under 1 m^2. of surface was somewhat greater than in 1946. As in 1946, the maximum occurred in the early days of July at the stations near the Hel Peninsula (G_1 and G_6). The numbers of eggs found were 259 and 250 under 1 m^2. of surface respectively. Seaward of these two stations, the number of eggs gradually diminished. Chart 2 shows the quantitative distribution of sprat eggs in 1947.

From these investigations we conclude that the spawning period of the sprat in the Gulf of Gdansk begins in the first part of May and lasts to the end of July. This accords with the fragmentary German investigations (Ehrenbaum and Strodtmann 1904, Strodtmann 1906, Heinen 1912, Strodtmann 1918, Mielck 1926, Strodtmann and Kändler 1934, Mielck and Künne 1935) carried out in the Gulf of Gdansk in the period 1903 to 1937. The

Table 1. Quantitative distribution of eggs and larvae of sprat (*Clupea sprattus* L.)

Date	Station	Eggs under 1 m.²	Larvae of surface	Date	Station	Eggs under 1 m²	Larvae of surface
			1938				
17.V	1	0	0	8.VI	IV	0	0
20.V	I	1	0	4.VII	31	0	0
25.V	II	0	0	„	32	2	0
28.V	III	0	0	5.VII	IX	0	0
2.VI	9	0	0	10.VII	51	0	0
„	10	1	0	„	52	0	0
„	11	4	0	„	53	0	0
8.VI	12	1	0	27.VII	XII	0	0
„	13	2	0	28.VII	XIV	0	0
			1946				
18.VI	A_1	43	6	15.VII	G_2	230	1
28.VI	Z_1	9	—	„	G_3	113	—
„	Z_2	30	—	„	G_4	206	24
„	Z_3	8	—	„	G_5	42	78
2.VII	G_1	246	83	16.VII	G_6	46	30
„	A_2	157	20	22.VII	G_7	38	6
15.VII	G_1	100	29	27.VII	Z_1	—	—
			1947				
9.V	G_2	1	0	2.VII	Z_1	37	0
29.V	G_2	22	0	„	G_6	250	1
„	G_1	11	0	11.VII	G_7	76	0
6.VI	Z_1	2	0	„	G_8	41	1
„	Z_2	2	0	„	Z_2	35	0
1.VII	G_1	259	0	„	Z_1	30	1
„	G_2	160	7	31.VII	Z_2	1	—
„	G_3	88	5	„	G_1	11	—
„	G_4	82	6	5.VIII	G_2	2	0
„	G_5	132	9	„	G_9	13	0
2.VII	Z_3	7	0				

maximum intensity of spawning occurs at the end of June and the first half of July.

The spawning ground comprises the whole of the Gulf of Gdansk, but the greatest densities of larvae and eggs are found in the open waters (Chart 2). During the actual spawning the region of greatest density of eggs changes its position in the Gulf of Gdansk.

Comparing the spawning of the sprat as observed in 1938, 1946, and 1947, it can be stated that the number of sprat eggs in 1946 and 1947 was considerably higher than in 1938. It appears from this that in the Gulf of Gdansk region the sprat stock — after a rapid decline in 1937 (D i x o n 1938) — is regenerating.

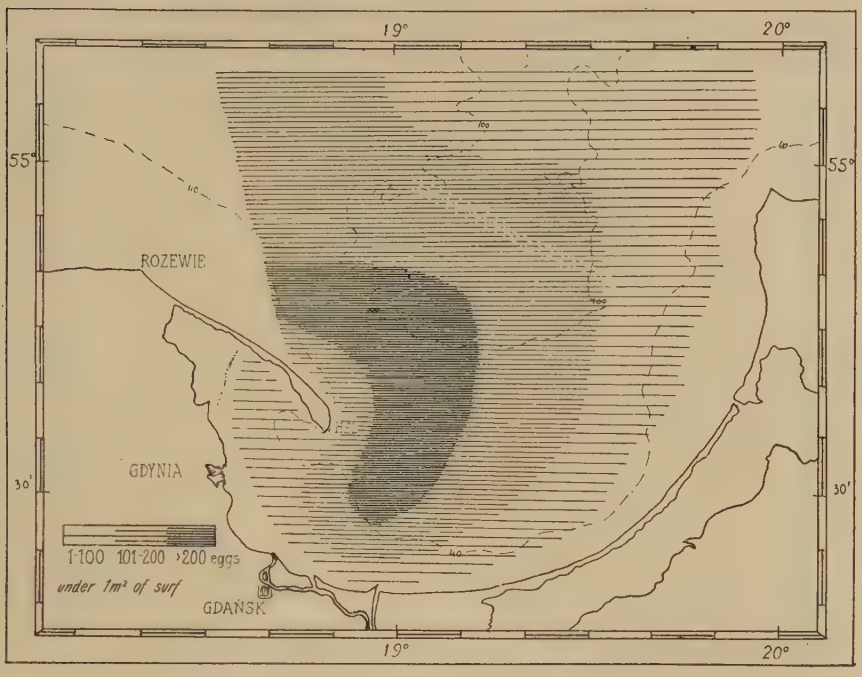

Chart 2. Quantitative distribution of sprat eggs in Gulf of Gdansk on 1st and 2nd July 1947.

2. *Gadus morrhua* L.

Table 2 gives the observed occurrences of cod eggs and larvae in 1938, 1946, and 1947.

In 1938 in the Gulf of Gdansk region 164 eggs and 12 larvae were caught at 10 stations, with a maximum of 54 eggs under 1 m². of surface on 2nd June.

In 1946 the spawning was considerably better, for at 10 stations 504 eggs and 131 larvae were caught, with a maximum of 262 eggs under 1 m². of surface on 15th August at station G_2.

The year 1947 brought a still greater intensity of spawning. At 21 stations 1898 eggs and 195 larvae were caught, with a maximum of 439 eggs under 1 m². of surface on 5th August at station G_2.

Numerous German observations on the spawning period of the cod (Ehrenbaum and Strodtmann 1904, Strodtmann 1906, Heinen 1912, Strodtmann 1918, Mielck 1926, Strodtmann and Kändler 1934, Mielck and Künne 1935) were collected by Kändler (1938), in order to get a general picture of this process. On the basis of this rather fragmentary material (observations from 16 stations during the period 1903—1937), Kändler concludes that in the Gulf of Gdansk the cod begins to spawn in March, with a maximum intensity in May and June. The end of this process is not

Table 2. Quantitative distribution of eggs and larvae of the cod (*Gadus morrhua* L).

Date	Station	Eggs under 1 m.² of surface	Larvae under 1 m.² of surface	Date	Station	Eggs under 1 m.² of surface	Larvae under 1 m.² of surface
			1938				
17.V	1	5	—	8.VI	13	13	1
2.VI	9	1	2	„	IV	4	0
„	10	23	4	4.VII	32	1	0
„	11	54	2	10.VII	51	48	0
8.VI	12	5	2	„	52	10	1
			1946				
18.VI	A_1	96	4	15.VII	G_2	262	22
28.VI	Z_3	—	—	„	G_3	—	—
„	Z_2	—	1	„	G_4	35	20
„	Z_1	—	—	„	G_5	7	25
2.VII	G_1	1	3	16.VII	G_6	—	1
„	G_2	97	47	„	G_7	—	—
15.VII	G_1	6	4	22.VII	G_8	—	4
			1947				
11.IV	G_2	145	5	11.VII	G_7	1	0
9.V	G_2	174	51	„	G_8	0	1
„	G_1	15	13	31.VII	G_1	11	1
29.V	G_2	80	37	5.VIII	G_2	439	14
„	G_1	0	0	„	G_9	250	8
1.VII	G_1	12	7	14.VIII	G_1	7	0
„	G_2	406	17	9.IX	G_2	25	2
„	G_3	152	7	„	G_{10}	2	0
„	G_4	153	14	13.IX	G_1	9	2
„	G_3	20	13	14.X	G_2	6	1
2.VII	G_7	0	5				

defined by K ä n d l e r, he merely states that even in September the eggs of cod occur in the area and he supposes that spawning finishes in October.

My observations can give no date for the beginning of the spawning period, because from January to March 1947 the Gulf was frozen, making expeditions impossible. When observations were started, spawning had already begun, since 145 eggs and 5 larvae were found under 1 m². of surface on 11th April at station G_2.

My observations, as opposed to K ä n d l e r's, suggest that the greatest intensity of spawning occurs in the months of July and August, while spawning in the Gulf of Gdansk appears to end in November; on 14th October only 6 eggs and 1 larva under 1 m². of surface were taken.

The area in which the cod spawns in Gdansk Deep is limited (Chart 3). The cod — a cold-water fish — spawns only in the deepest water layers of the Gulf of Gdansk. The eggs of cod were found only in

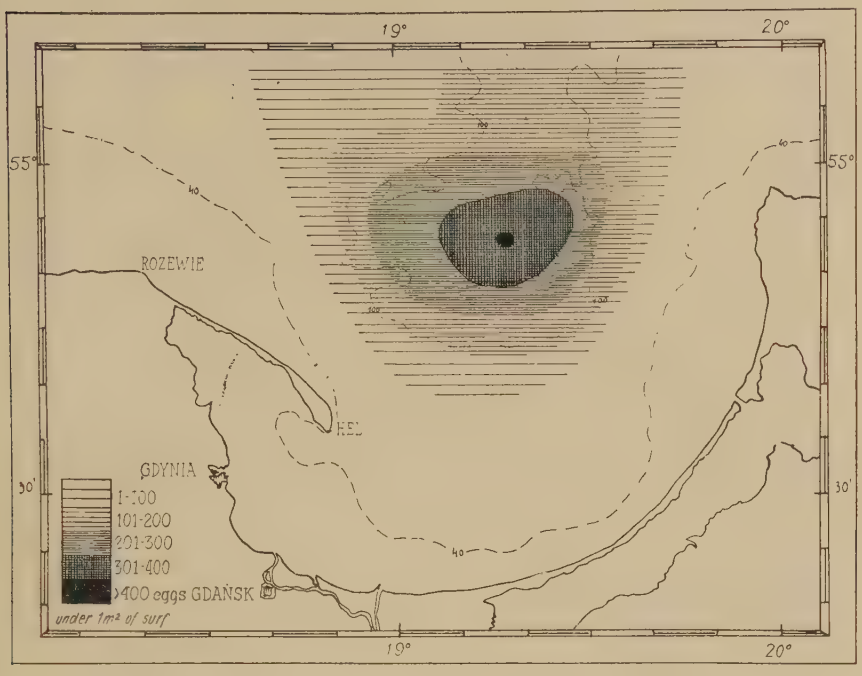

Chart 3. Quantitative distribution of cod eggs in Gulf of Gdansk on 1st and 2nd July 1947.

those localities in which the depth of water exceeded 70 m., in accordance with the fact that eggs of cod are pelagic, but only in waters the salinity of which is higher than 10 ‰. Such a salinity is found in Gdansk Deep only where the depth is greater than 65 m.

Chart 3 shows the area in which the cod spawned in 1947. The greatest density of eggs was found at the station where the depth was greatest and where the salinity reached its highest value.

Figure 1 illustrates the seasonal course of the spawning of the cod in Gdansk Deep in 1947, as given by the observations made at station G_2, this being the station with the greatest depth of water. The curve showing the number of eggs under 1 m². of surface during the period of observation exhibits a trough in May. It seems to me that this can be attributed to the changes observed in the temperature, salinity and oxygen satur-

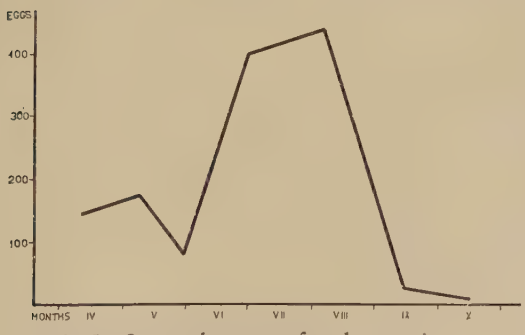

Fig. 1. Seasonal course of cod spawning at station G_2 in 1947.

Table 3. Temperature, salinity, and oxygen content of the bottom water in Gdansk Deep in 1947.

Date	11.IV	9.V	29.V	1.VII	5.VIII	9.IX
Temp. °C.	5·0	5·0	2·30	2·70	2·40	3·40
Salinity ‰	11·22	11·13	11·92	12·25	12·12	12·48
Oxygen %	21·77	18·72	72·81	55·39	59·37	70·64

ation of the water (Table 3). It is probable that in the period of observation an inflow of water took place from the western part of the Baltic.

It may be noted that when the number of eggs under 1 m². of surface decreased, the temperature near the bottom fell from 5° to 2·3° C.; at the same time the salinity increased from 11·13 ‰ to 11·92 ‰, and the oxygen saturation increased from 18·72 % to 72·81 %.

With the observations available I can determine the dates of neither the beginning nor the end of the cod spawning, but it may be stated that the greatest intensity of spawning occurs in the period July—August. The end of spawning probably falls in November. The locality of the cod spawning is in the deep water layers in Gdansk Deep, where the depth exceeds 70 m. and the salinity is more than 10 ‰. The largest concentrations of eggs are found in the greatest depths.

The eggs of cod, as well as of sprat, are more numerous in the post-war years than in 1938.

3. *Onos cimbrius* L.

This species needs the same conditions for spawning as the cod, and the eggs were found at the same stations as cod eggs were found. The quantitative distribution of the eggs of *Onos cimbrius* is the same as that of the cod, since its eggs appear most abundantly at the deepest stations.

Table 4 presents the data for this species from observations in 1938, 1946, and 1947.

In 1938, when the cod spawning was but meagre, the number of eggs of *Onos cimbrius* caught during the expeditions from the middle of May to the middle of July amounted to 722, with a maximum of 116 eggs under 1 m². of surface.

In 1946, from the middle of June to the end of July, 221 eggs were taken, with a maximum of 96 eggs under 1 m². of surface.

In 1947, from about the beginning of the spawning period, namely, the beginning of May, to the end of July — thus over a longer period than in the previous two years — only 215 eggs were caught, with a maximum of 70 eggs under 1 m². of surface. In the following months, however, from August to October, 253 eggs were caught; moreover, the maximum number of eggs under 1 m². of surface falls in this period and amounts to 81 eggs.

The observations over the whole period appear to indicate that in the case of *Onos cimbrius* the main intensity of spawning is approximately in the month of August; at any rate, such was the case in 1947.

Table 4. Quantitative distribution of eggs and larvae of *Onos cimbrius* L.

Date	Station	Eggs under 1 m.² of surface	Larvae under 1 m.² of surface	Date	Station	Eggs under 1 m.² of surface	Larvae under 1 m.² of surface
			1938				
17.V	1	4	0	8.VI	13	70	3
27.V	III	4	0	„	IV	85	0
2.VI	9	49	4	4.VII	32	18	0
„	10	116	3	10.VII	51	98	0
„	11	98	1	„	52	79	1
8.VI	12	101	0				
			1946				
18.VI	A_1	12	0	15.VII	G_2	95	3
28.VI	Z_3	—	—	„	G_3	—	—
„	Z_2	—	—	„	G_4	15	1
„	Z_1	—	—	„	G_5	16	1
2.VII	G_1	3	—	16.VII	G_6	—	1
„	G_2	35	1	„	G_7	—	—
15.VII	G_1	32	—	22.VII	G_8	13	—
			1947				
11.IV	G_2	0	0	11.VII	G_7	6	0
9.V	G_2	11	0	„	G_8	0	0
„	G_1	0	0	31.VII	G_1	20	0
29.V	G_2	8	1	5.VIII	G_2	81	1
„	G_1	0	0	„	G_9	64	2
1.VII	G_1	13	0	14.VIII	G_1	21	0
„	G_2	70	1	9.IX	G_2	34	0
„	G_3	42	1	„	G_{10}	2	0
„	G_4	24	2	13.IX	G_1	43	1
„	G_5	17	0	14.X	G_2	8	1
2.VII	G_6	4	0				

The German observations, taken as a whole, correspond with mine in regard to the spawning period of *Onos cimbrius*. Spawning evidently begins in the first part of May. There are no observations yet relating to the end of the period, but I presume the spawning finishes in November.

The locality and the conditions of spawning are the same as those of the cod.

In comparison with the abundance of eggs of *Onos cimbrius* in 1938, the numbers of eggs in 1946 and 1947 decrease yearly, which may be associated with the great increase in the numbers of cod.

Summary.

The observations of the quantitative distributions of eggs and larvae of *Clupea sprattus* L., *Gadus morrhua* L., and *Onos cimbrius* L., indicate

that the eggs of the first two species were more numerous in post-war years than in 1938, while, in opposition to this, the eggs of *Onos cimbrius* were more abundant in 1938.

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Rearing Experiments at the Flødevigen Seafish Hatchery 1943—1946.

By

Alf Dannevig.

DURING and since the last years of the war we have experimented on the rearing of larvae of the oyster (*Ostrea edulis*) and of different fish.

As the results of the rearing of oyster larvae in our salt-water pond often showed considerable variation ("Oppdrett av østersyngel". Rep. Norwegian Fish. and Mar. Invest., Vol. 8, No. 3), it was planned to study the larvae in the laboratory, with special attention to food requirement.

The experiments were carried out by Cand. real. Else Fagerland Dannevig.

In order to prolong the spawning season, adult oysters were brought into the laboratory during winter, and kept in aquaria in running sea water, artificially heated, with temperatures to ca. 25°C. The oysters were not supplied with plankton or any food except what occurred in the sea water. They gradually matured and spawned. It was observed (by Technical Assistant Sigfred Hansen) that spawning might be hastened by putting the ripe oysters in water of a lower temperature. In this way it was possible to get the larvae when wanted. This was of special importance when using the oyster larvae as food for fish larvae (see later).

The oyster larvae were always of a high quality, and lived perfectly for weeks in small aquaria at room temperature. But the growth — if any — was always very poor.

At first attempts were made to rear the larvae in aquaria with sea water enriched with phytoplankton, but results were poor. Later cultures of special species were employed. These were sorted out from sea water from the oyster pond. Some of them are not described.

On 1. July 1943 an experiment was made with cultures of *Chlorella* sp. and brown flagellates $<6\ \mu$ in 1·5 l. glasses. Two controls were placed at a distance of 1·5 metres from the window facing south. One of them was shaded from direct light. On 3. August few oyster larvae were left. In the glasses supplied with *Chlorella* none of the

larvae were more than 200 μ, as was also the case with those supplied with brown flagellates in the two shaded glasses. In the glasses standing in full light some larvae = 240 μ were present.

Experiments with the same flagellates in larger aquaria gave no positive results. In the unfiltered water, many ciliates occurred, which were great competitors for the food, and sometimes appeared to be full of phytoplankton. Various species of zooplankton also developed.

As it was difficult to observe what occurred in the large aquaria, experiments were made in Petri dishes. On 2. July the following series were started:

Oyster I
- A. *Chlorella*
- B. Various brown flagellates $<6\ \mu$
- C. No food added.

Oyster II
- D. } Various brown flagellates $<6\ \mu$.
- E. }

Unfiltered sea water was used, but the larvae were transferred each day to clean dishes.

After 6 days the results were:

A. The larvae had *Chlorella* in the intestine. No individual exceeded 175 μ.

B, D, and E. The larvae measured 200—220 μ.

C. The larvae measured $<175\ \mu$.

On the 13th day:

A. All alive but no growth.

B. All alive; some had grown well. Ciliates present. The larvae accumulated near the bottom.

D and E. Many had grown very well.

On the 18th day:

A. All dead.

B. Few alive, but large.

C. Many still alive, but colourless.

D. Few alive, measuring 230—280 μ.
(The size when attachment occurs is about 275 μ.)

E. As D, but two had attached themselves to bits of oyster shell. They lived till 5. Aug. when they measured 840 and 500 μ.

In D and E, the larvae being from the same oyster, it was noticed that the shape of the larvae was quite extraordinary, the shells being globular. On the 34. day the transverse diameter, the "thickness" was 240 µ and the "length" only 230 µ.

On 21. July another experiment was started in the same way. The food added was cultures of brown flagellates <6 µ, about 8—10 µ and *Chlorella*. In 15 days the larvae fed with the small flagellates had attained a size of 255—260 µ. Those fed with the larger flagellates measured a maximum of 195 µ. Among the larvae fed with *Chlorella* the two largest measured 190 and 215 µ.

The last experiment in 1943 was started on 22. July in a larger aquarium, the water being filtered through charcoal and cultures of flagellates added.

On 5. August, when the experiments were discontinued, many larvae had a diameter of 200—225 μ, some 230—240 μ.

The larvae grew better in this than in earlier experiments in the same aquarium when it was supplied with unfiltered water.

In 1944 experiments were started on 26. April. In each of 8 Petri dishes 30 newly spawned larvae were placed. Four of the dishes were kept in the office at a temperature of approximately 18—20°C., and another four in the aquarium room, the laboratory, where the temperature varied from approximately 12 to 15°C. in April and 12 to 16°C. in May.

Two brown flagellates, <6 μ, "Flag 3" and "Flag 4", had been isolated and cultured. They were very much of the same appearance, but could be separated when fixed. These were used for food. In each room two dishes were fed with "Flag 3", the other two with "Flag 4".

After 8 days the larvae were lively in all glasses except in "Flag 4" in the laboratory, where they accumulated near the bottom and were light in colour.

After 12 days the larvae in the office had grown, but not those in the laboratory, the temperature apparently being too low.

On the 15th day several larvae in the office were turning oblique in "Flag 4". In "Flag 3" a sparse growth had taken place. In the laboratory nearly all were dead in "Flag 4"; in "Flag 3" the larvae were quite normal, but no growth had occurred.

On examining the flagellates, it was found that "Flag 3" was very lively in both places, while "Flag 4" flourished only in the office (higher temperature?).

In the office on the 23rd day most of the larvae in "Flag 4" had turned oblique, while one had in "Flag 3".

After 31 days the condition was as follows:

Laboratory:

Flag 4_1: 1 alive but abnormal.
Flag 4_2: 4 „ but no growth.
Flag 3_1: 17 „ no growth, colourless.
Flag 3_2: 22 „ no growth, colourless.

The experiment in this room was brought to an end.

Office:

Flag 4_1: 28 alive, several large.
Flag 4_2: 27 „ one with foot and eye point.
Flag 3_1: 5 „ practically no growth.
Flag 3_2: 24 „ had grown a little, but none oblique.

On 12. June, after 48 days, the experiment was discontinued. On that day we had the following:

Flag 4_1: 26 alive, 3 had attached themselves.
Flag 4_2: 26 „ 10 had attached themselves (7 on pieces of oyster shell, 3 on glass).

Flag 3_1: 1 alive
Flag 3_2: 12 „
} The largest = 210 µ.

From these experiments we may draw the following conclusions:

Quality of food is a prominent factor in rearing oyster larvae. In accordance with the results of J. R. Bruce, M. Knight, and M. W. Parke ("Rearing of Oyster Larvae on an Algal Diet". Journ. Mar. Biol. Assoc., **24**, 1940) a brown flagellate <6 µ, called by us "Flag 4", is by far the best. Another naked brown flagellate, "Flag 3", of the same size is definitely inferior.

Cultures of these two flagellates have demonstrated that "Flag 4" has its optimum at room temperature. "Flag 3" thrives at lower temperatures, ca. 10°C.

The presence of other planktonic algae and ciliates seemed to be harmful to the well-being of the oyster larvae.

The experiments indicate that normal room temperature is beneficial to the oyster larvae.

The rearing of larvae of salt-water fish has been difficult. Positive results were obtained by H. C. Dannevig in 1895 (*Pleuronectes platessa*), by Fabre-Doumergue in 1905 (*Solea vulgaris*), and by Kotthaus and Schach, 1937—1939, (Herring). In 1938 Mr. Rollefsen achieved considerable success with *Pl. platessa* and a bastard *Pl. platessa* ♀ × *Pl. flesus* ♂. He was of the opinion that his success was purely a question of appropriate food; he used the larvae of *Artemia salina*.

At this station we have often reared cod larvae in our salt-water ponds, but failed to do so in the laboratory. At the time, however, our facilities were not convenient. In 1939 we had a new building, and although it was not possible on account of the war to have the laboratory completely fitted out, we have undertaken some experiments on different species, Technical Assistant Sigfred Hansen being in charge of the work.

The water supply for the laboratory comes through iron pipes from a salt-water pond, in which the sea water is regularly renewed, the water being drawn from a depth of approximately 15 metres.

The windows face south and west, so that there is plenty of daylight. In 1946 the windows facing west were shaded by jalousies, which permitted the daylight to enter more or less freely, but not direct sunlight. The jalousies were placed outside the windows in order that the heat absorbed should not influence the air temperature in the laboratory.

The temperature varies rather widely, however, in this room which is but sparsely heated during winter.

As the hatchery could not be operated during the war, the fish larvae used for the experiments were hatched in the laboratory, partly from eggs artificially fertilized, or from eggs spawned naturally in our aquaria.

The larvae were fed with various forms of plankton; for example, raw cultures of phytoplankton, cultures of single species of green algae and naked flagellates, larvae of *Balanus, Pomatoceros, Mytilus,* oysters and *Artemia,* especially the two latter.

In the experiments several forms of glass vessels were used, partly with constantly circulating sea water, partly with total, or nearly total, renewal of sea water each day. A modification of a plunger jar was also tried. The volume of water in the vessels was from a few litres to a hundred litres or more. The best results in these aquaria (though none were entirely satisfactory) were obtained in two-litre glasses fitted with stirring apparatus.

In 1945 we adapted for use as aquaria glazed earthenware pipes normally used for drains. The pipes used were 12″ in diameter, and 30″ in length. The lower end was made watertight with cement. A galvanized-iron pipe was attached to the bottom and bent up outside towards the top of the drain pipe. The height of the iron pipe regulates the water level in the tube. In order to prevent the larvae from entering the iron pipe, a sand filter was placed on the bottom of the aquarium. The water was led into the aquarium by means of a rubber tube, fastened to the wall of the aquarium. In this way the inflowing water caused the main body of water to rotate slowly.

In 1946 one of these pipes was placed in a water bath in order to prevent sudden variations of temperature. At the same time we began filtering the sea water through silk net, to prevent the formation of air bubbles in the aquaria, by bringing the gas pressure of the sea water into equilibrium with that of the atmosphere. The filter net, constructed as a small plankton net, was fastened to the ceiling, and the water ran down as a thin film outside the net into a container where it was distributed to the different pipes. As will be mentioned later, this filtration process may be beneficial in another way also.

The experiments with these pipes in 1946 were encouraging — some very satisfactory. Before giving some of the later results, we may remark on the earlier experiments in the glass aquaria. The hatching of the eggs is usually successful in relatively small glasses. For planktonic eggs the quantity used must not be so large that the eggs accumulate in layers near the surface. Demersal eggs, e. g., herring, are deposited on glass slides and fertilized dry — or in some cases in sea water. They are hatched in constantly renewed water. The hatching of eggs of all species dealt with generally succeeded in a satisfactory way, and the larvae thrived till the yolk-sac was absorbed. In some cases the larvae could not be induced to take food of any kind. On examining

the gut, only "green remains" were found. (cf. Marie Lebour: "The Food of Young Fish". No. III. Plymouth, 1919.) In some cases phytoplankton was found in the intestine of *Pl. microcephalus*. Feeding with cultures of phytoplankton, however, gave no positive results. The survival of the larvae was no greater in experiments in which larvae were supplied with plankton than in controls in pure sea water. Indeed, it may be the case that phytoplankton was in some way or another harmful to the fish larvae. This may be compared with what was said about the feeding of oyster larvae. The best results with oyster larvae were obtained when the special flagellate ("Flag 4") was given to the oyster larvae living in filtered sea water.

In other experiments the larvae of *Pleuronectes microcephalus* and *Scomber scomber* took the food, namely, larval oysters, and *Artemia*. The larvae were seen chasing the food organisms, and the gut appeared well filled. After some time — a week or two — the larvae ceased to take food, and died.

In all our earlier experiments, but few individuals reached a length of a couple of centimetres, the species concerned being mainly *Clupea harengus, Pleuronectes microcephalus* and *Scomber scomber*. The swallowing of gas bubbles caused great mortality among the herring.

As a result of the encouraging nature of preliminary experiments in an earthenware pipe in 1945, in 1946 we started rearing in eight aquaria of this type. The results were far better than in earlier years; the later batches thrived especially well. Filtered water, constantly renewed, was used. In two instances the pipe was placed in a bath of sea water. With this arrangement, we had no trouble from gas bubbles.

For the smaller fish larvae, oyster larvae were used for food; for the larger, *Artemia* and crustacean plankton collected from the sea with a plankton net. The advanced stages of young herring and soles *(Solea vulgaris)* were transferred to the lobster rearing apparatus (cf. Dannevig: "The Rearing of Lobster Larvae". Bergen, 1928), and fed with chopped crab or *Mytilus*.

It is unnecessary to describe the results in detail, but it may be mentioned that the best result with herring was the rearing of 105 individuals out of 500 larvae to a size large enough for the vertebrae to be counted. The mackerel also thrived very well — though trouble arose from cannibalism, the growing fish evidently being crowded in too small a space. In two experiments soles were hatched and reared with no appreciable mortality. The young fish were still living in February 1947, only a few succumbing when the water temperature fell during winter to 1·2° C. The rest had to be brought into the laboratory where the water temperature could be kept up. About 600 are still living and in good condition.

The evident improvement in the methods employed in rearing fish larvae in a laboratory was achieved when the glass aquaria were replaced by the relatively deeper and darker earthenware pipes. Results were still better when the pipes were placed in a water bath, and filtered sea water used.

What the beneficial factors really are can hardly be decided from these early experiments.

If it is desired to rear fish larvae in order to study the effect of heredity, or of environmental factors, it is necessary to obtain a high percentage of survivors. Otherwise it will remain open to question whether there is any correlation between mortality and any of the factors we want to study.

The results obtained throw some light, however, on the "quantity of heat" necessary to hatch herring eggs.

Examination of the results of the hatching of herring showed that the time taken varied much although the temperature remained the same. The "quantity of heat" (number of days × temperature in C°.) was calculated, and the results arranged in order of the quantities obtained (see Table 1).

Table 1.

	Date of fertilization	Number of days before hatching took place	Average temperature during hatching	Number of[1]) days + 1 × degrees C.
1	2.3.44	26	3·89 °C.	105·1
2	5.3.46	32	3·30	108·9
3	20.2.46	40	2·66	109·0
4	5.3.46	32	3·31	109·2
5	19.2.43	20	5·22	109·6
6	3.3.44	27	4·21	117·9
7	12.3.45	21	5·41	119·1
8	15.4.44	14	8·00	120·0
9	7.4.43	15	7·58	121·2
10	22.2.43	23	5·42	130·1
11	5.5.42	18	7·20	136·8
12	10.3.45	24	5·53	138·2
13	20.3.46	26	5·41	146·1
14	23.4.45	19	8·56	171·2

It will be seen that the first 5 experiments are much the same, the "total heat" varying from 105·1 to 109·6. These variations are not greater than may be expected with the methods employed.

The next 4 vary between 117·9 and 121·2. A third group varies between 130·1 and 146·1. The last experiment stands alone with the high value of 171·2.

The eggs which required the least heat were fertilized early in winter, between 19.2 and 5.3; the eggs of the next group, between 3.3 and 15.4. In the third group the fertilization date varies from 22.2 to 5.5.

These experiments are not sufficient to provide an explanation of the differences in the "amount of heat" needed; some notes made as to the parent herring used in the different experiments suggest, however, that differences in herring populations or "races" may be involved. For a detailed consideration of this problem special experiments at constant temperatures are required.

[1]) Including the day of fertilization.

Du Rôle joué par les Facteurs internes dans certaines Migrations de Poissons: Etude critique de diverses Méthodes d'Investigation.

Par

Maurice Fontaine.

IL est certainement superflu de rappeler ici l'extrême diversité des migrations des poissons et je soulignerai d'abord simplement l'orientation majeure des recherches entreprises jusqu'ici pour élucider leur déterminisme. La plupart des travaux ont eu surtout pour objet la recherche des facteurs du milieu qui conditionnent les déplacements du poisson d'une aire à une autre. Cette recherche peut sembler se suffire à elle-même dans le cas des migrations où tout se passe comme si le poisson tentait simplement de se maintenir dans des eaux de mêmes conditions physiques et physicochimiques, ce qui le conduit à fuir les variations du milieu ambiant: variations saisonnières, par exemple. Il apparaît alors comme un organisme physiologiquement stable, contraint de vivre dans un milieu toujours à très peu près le même, c'est à dire dans une marge de variabilité plus étroite que les espèces sédentaires. Mais bien d'autres migrations — et les plus amples — semblent déterminées par la recherche de conditions écologiques nouvelles et diverses théories sont nées, nous représentant le poisson migrateur à la recherche de certaines eaux de salinité, de température, d'oxygénation, de pH, de tension de gaz carbonique parfaitement déterminés. C'est surtout le milieu extérieur qui retint l'attention et polarisa toutes les recherches, et l'on passait généralement très vite sur les causes internes qui, à telle ou telle étape du développement, conduisent le poisson à rechercher telle ou telle norme écologique nouvelle, ou à abandonner telle ou telle condition écologique lui ayant jusqu'alors convenu. Il me semble cependant que, dans ce dernier cas, les causes internes doivent retenir toute notre

attention, car elles représentent un facteur primaire par rapport aux causes externes. Si, en effet, dans un milieu marin donné, quelques espèces seulement, parmi bien d'autres, doivent, à une époque déterminée, quitter leur habitat, c'est, de toute évidence, qu'une physiologie différente de celle des espèces sédentaires leur impose ce changement de milieu.

Et c'est là le problème qui va, si vous le voulez bien, retenir notre attention: quelles sont ces différences de fonctionnement physiologique entre sédentaires et migrateurs? Ces différences sont elles profondes? Portent elles sur l'absence ou la présence d'une fonction? Une telle hypothèse peut, à première vue, être soutenue pour l'anguille; K r o g h a trouvé que la branchie de ce poisson n'est pas capable d'absorber les ions Cl à partir de solutions très diluées — ceci contrairement à tous les autres téleostéens d'eau douce. Nous avons pensé que, lors de la transformation de l'anguille jaune en anguille argentée, et du jeûne qui l'accompagne, cette particularité pouvait entraîner une déminéralisation de l'animal, déminéralisation que nous avons effectivement constatée avec Mlle C a l l a m a n d, et qui confère sans doute ce caractère passif, asthénique, à l'avalaison de l'anguille, à son retour à la mer.

Mais c'est là un cas particulier qu'il me semble difficile de généraliser. En effet, une même famille, comme celle des Salmonidés; ou comme celle des Clupéidés, peut comprendre des espèces très voisines du point de vue de l'organisation, et dont pourtant les unes sont sédentaires, les autres migratrices, holobiotiques ou amphibiotiques. On peut observer, dans un même genre toute une gamme dans l'amplitude des migrations, par exemple, *Salmo fario,* truite de ruisseau, *Salmo trutta,* truite de mer, *Salmo salar,* saumon; et, même au sein d'une espèce typiquement migratrice, comme le *Salmo salar,* certains individus peuvent atteindre la maturité génitale sans avoir été contraints de migrer. Ainsi, s'impose l'idée que, pour ces espèces, le caractère migrateur n'est pas un caractère absolument fondamental, reposant sur une structure anatomique, cytologique, physiologique originale, mais qu'il résulte plutôt de différences quantitatives portant sur des intensités de fonctionnement. D'ailleurs, le cas de l'anguille peut fort bien rentrer dans le cadre de cette conception : l'anguille peut être considérée comme le terme extrême de toute une série de poissons d'eau douce qui montrent la possibilité d'absorber des chlorures contre les forces osmotiques, non d'une façon uniforme, mais à des degrés divers, jusqu'à des seuils très différents, les uns élevés (*Acerina cernua,* 1·58 mm. de Cl), les autres très bas (*Leuciscus rutilus,* 0·02). L'anguille serait simplement l'espèce dont le seuil serait le plus élevé dans cette vaste série. Ainsi s'expliquent plus facilement toutes les formes intermédiaires qui constituent une chaine continue allant des espèces sédentaires aux plus typiques migrateurs amphibiotiques.

Quels sont donc ces facteurs internes qui sensibilisent l'espèce migratrice à des facteurs du milieu auxquels restent insensibles les espèces sédentaires? N'est il pas naturel de songer au système endocrinien puisque ces migrations se produisent toujours à un moment du cycle vital

où les conditions physiologiques comportent presqu'obligatoirement un hyperfonctionnement ou un dysfonctionnement endocrinien. Elles se produisent, ces migrations, le plus souvent au début ou au cours d'une maturation génitale dont l'hypophyse porte certainement une responsabilité majeure, elles se produisent aussi — et c'est le cas de la jeune anguille — aussitôt après la métamorphose, et l'on observe pendant, et à la suite de cette métamorphose, une hyperactivité thyroïdienne, elles se produisent encore lors d'une phase d'accélération de croissance attribuable certainement pour une grande part à une hyperactivité des glandes endocrines dynamogènes (c'est le cas du smolt, ou jeune saumon de descente — travaux de Hoar et de Orton, 10-11-17).

Mais comment un hyperfonctionnement des glandes endocrines peut-il intervenir pour déclancher un changement de milieu? On peut songer à deux types de mécanismes: directs et indirects. Des expériences de Koch et de Mlle Callamand (12,2) ont montré que l'administration d'hormone thyroïdienne — en injection ou en ingestion — diminue l'efficacité des mécanismes de régulation osmotique du milieu intérieur. Or, tous les téléostéens, qu'ils soient d'eau douce ou d'eau de mer, possèdent un milieu intérieur qui présente une grande différence de pression osmotique avec le milieu extérieur, et ils ne peuvent maintenir constante cette différence que par la mise en jeu de mécanismes divers coordonnés, faisant intervenir les branchies, le rein, le tube digestif, et concourant tous à maintenir par un travail constant, un équilibre dynamique entre milieu intérieur et milieu extérieur.

Donc, si l'ensemble de ces mécanismes régulateurs vient à fléchir chez un poisson marin migrateur, celui-ci sera menacé d'une déshydratation, d'une hyperminéralisation, il sera par suite contraint de quitter les eaux marines et de trouver des eaux plus douces, (estuaires et fleuves). Si, au contraire, cette défaillance se produit chez un poisson en eau douce qui ne s'alimente plus, il y aura déminéralisation du milieu intérieur (cas de l'anguille argentée) et par suite, soit asthénie entraînant l'avalaison du poisson (Fontaine et Callamand, 7), soit déplacement actif du poisson selon un gradient de salinité (Koch, J., 12).[1])

C'est là un mécanisme vraisemblable. Le point sur lequel on peut encore discuter dans bien des cas est celui de savoir si le poisson est chassé par les caractéristiques d'un milieu qui ne lui convient plus, ou s'il se dirige vers des eaux dont les propriétés lui conviennent mieux. C'est une distinction qu'il est souvent très difficile de trancher et sur laquelle nous ne nous attarderons pas.

Par contre, nous noterons que si le mécanisme envisagé est probable dans le cas d'une migration amphibiotique, il n'est sans doute qu'un élément d'un déterminisme plus complexe. Certaines glandes inter-

[1]) La poursuite de ces recherches nous a conduits à faire quelques réserves sur la valeur générale de cette interprétation du mécanisme de l'avalaison (voir Fontaine et Callamand: Nouvelles recherches sur le déterminisme physiologique de l'avalaison, Bull. Museum nat. Hist. Natur., avril 1948). Note ajoutée lors de la correction des épreuves.

viennent très vraisemblablement directement, comme par exemple, le lobe postérieur hypophysaire dont on connaît le rôle important dans le métabolisme de l'eau.

D'autre part, le mécanisme précédent ne peut plus être invoqué quand il s'agit d'autres types de migrations ou de certaines étapes de migrations, par exemple, quand un poisson se déplace dans un milieu de salinité uniforme. C'est le cas de quelques poissons marins à migrations holobiotiques, le cas des truites de lac, qui remontent les affluents au moment de la maturation des gonades, le cas enfin des poissons potamotoques comme le saumon ou l'alose, qui, parvenus dans les eaux douces, remontent encore fougueusement le cours des fleuves parfois sur plusieurs centaines de kilomètres.

Alors, il faut envisager d'autres mécanismes, et si, dans certains cas, la recherche de facteurs externes convenables comme une température déterminée, peut être invoquée, et s'il nous faut encore chercher comment l'évolution endocrinienne à un stade déterminé peut imposer au poisson la recherche d'une nouvelle valeur de ce facteur physique, dans d'autres cas, on a l'impression très nette que c'est la lutte à contre-courant qui mène le jeu, et l'on songe évidemment encore à ces facteurs internes, à ces glandes endocrines dynamogènes (thyroïde-surrénales) dont l'hyperfonctionnement se traduit par un besoin maladif d'action, de combativité, et sans doute, dans le cas qui nous intéresse, par un rhéotropisme positif.

Nous voici donc conduits par ces diverses données d'observation ou d'expériences à entreprendre une étude des fonctionnements endocriniens. Cette étude devrait porter non seulement sur l'évolution du système endocrinien au cours d'un cycle de migration, mais sur la comparaison de cette évolution chez des espèces sédentaires et migratrices de position systématique voisine. Elle devrait atteindre plusieurs espèces migratrices pour que nous soyons en mesure de distinguer le particulier du général, de mettre en relief les grandes lignes générales de phénomène, d'atteindre en un mot les divers facteurs du dénominateur commun du déterminisme endocrinien des migrations.

Ce n'est évidemment pas là l'oeuvre d'un seul homme, ni d'un seul laboratoire, et c'est pourquoi je crois utile, dans un congrès de cette nature, de discuter des méthodes qui sont à notre disposition pour attaquer le problème.

Nous pouvons d'abord, et nous devons effectuer l'histologie des glandes endocrines, à des étapes bien déterminées de la migration. Dans une importante étude de l'hypophyse et de la thyroïde du hareng (1) Hermann Buchmann, en 1940, a montré l'existence d'un cycle d'activité de ces glandes au cours du développement du hareng, la métamorphose et la période post-métamorphosique d'une part, la période de la reproduction d'autre part, étant caractérisées par une hyperactivité de ces glandes[1]). Malheureusement, l'auteur avait essentiellement pour

[1]) L'interprétation faite par Buchmann de certaines images histologiques apparait d'ailleurs discutable. Nous reviendrons ultérieurement sur ce point.

but de montrer que ces phénomènes (métamorphose et reproduction) dépendent étroitement, comme chez les autres vertébrés, des glandes endocrines, et il ne nous donne aucune précision sur la situation géographique des harengs étudiés, sur la situation migratrice des harengs proches de la maturité sexuelle. Cette étude serait donc à reprendre, avec, pour principal objectif, les relations existant entre l'état de ces glandes et le comportement du hareng, mais on peut penser qu'elle serait féconde. Dans son important mémoire sur le hareng (15) Le Gall écrit en effet que le renversement du rhéotropisme du hareng correspond à une modification marquée de l'état physiologique du poisson. Le rhéotropisme positif se manifeste "au moment où les réserves graisseuses accumulées dans l'intestin se trouvent mobilisées pour être transformées dans l'organisme au profit des glandes génitales qui entrent précisément dans une phase active d'élaboration des produits sexuels". C'est là une observation qui est en parfait accord avec une hyperactivité hypophysaire et thyroïdienne. Au contraire, quand le rhéotropisme positif disparaît, alors les poissons "accumulent dans les mésentères intestinaux des réserves graisseuses", processus qui va de pair avec un certain état de repos des glandes considérées. Cette étude histologique des glandes endocrines est donc et sera donc d'une aide précieuse, toutefois, ses résultats ne doivent pas être accueillis sans certaines réserves. Tout d'abord, si, pour une glande comme la thyroïde, les auteurs sont d'accord sur un certain nombre de tests histologiques bien représentatifs de son état fonctionnel, pour d'autres glandes, comme la cortico et la médullosurrénale, les opinions sont beaucoup moins cohérentes. Une autre réserve qui doit être faite, et qui me semble la plus importante, résulte des travaux récents de Morton, Chaikoff et coll. (16). Ces auteurs ont en effet montré, grâce à l'utilisation de l'iode radioactif, que, dans l'organisme du mammifère la glande thyroïde n'était pas le seul tissu capable de synthétiser l'hormone thyroïdienne. A des animaux thyroïdectomisés tout jeunes et dont on laisse le métabolisme tomber à 50 % de sa valeur initiale, donnons de l'iode radioactif, puis sacrifions les animaux 96 heures après cette injection, et recherchons ce qu'est devenu cet iode, nous en trouvons une partie importante à l'état minéral, mais nous en trouvons 30 % à l'état organique, dont plus de 8 % sous forme de thyroxine, et 20 % sous forme de diiodotyrosine. A partir de cet iode radioactif, l'organisme sans glande thyroïde a donc été capable de faire la synthèse de l'hormone thyroïdienne. Sans doute cette synthèse n'est pas quantitativement suffisante chez le rat pour assurer une vie normale, mais elle existe et c'est là une acquisition très importante, car elle montre que l'activité de la glande endocrine peut n'être qu'une partie de la fonction endocrinienne générale de l'organisme. Pourquoi ces conclusions me semblent-elles particulièrement importantes en ce qui concerne les poissons? C'est parceque je crois, avec un certain nombre de biologistes, que l'évolution s'est faite dans le sens d'une spécialisation organique, et je pense que cette spécialisation s'est particulièrement manifestée dans les glandes endocrines qui jouent un rôle

si important dans les phénomènes de coordination des fonctions, dans les phénomènes d'intégration.

Dès lors, si même chez les mammifères qui se trouvent au sommet de l'échelle, nous constatons que la fonction thyroïdienne peut s'effectuer, dans une faible mesure, en dehors de la glande thyroïde, ne pensez-vous pas que chez les poissons, ou cette glande thyroïde présente d'ailleurs une très grande variabilité de forme et de structure, la fonction extra glandulaire peut occuper une place beaucoup plus importante? Nous ne pouvons plus alors affirmer que la fonction glandulaire marche toujours de pair avec la fonction thyroïdienne tissulaire plus ou moins générale ni que l'état fonctionnel de la glande représente toujours fidèlement le degré d'activité de la fonction thyroïdienne globale. Il y a peut-être là l'origine de certaines observations qui ont conduits quelques auteurs à douter du rôle métabolique de la glande thyroïde chez les poissons en dehors de la métamorphose. Quoiqu'il en soit, ces réserves n'ont pour but que faire l'interprétation des résultats plus prudente, mais il n'en reste pas moins que les données recueillies à partir de l'histologie des glandes endocrines doivent constituer un élément important d'une telle étude. Nous avons actuellement en cours de telles recherches sur l'hypophyse et la thyroïde de migrateurs amphibiotiques, et déjà, quelques résultats intéressants semblent se dégager. Par exemple, nous avons montré, avec Mlle C a l l a m a n d, qu'au moment où l'anguille s'argente, quand elle se prépare à son grand voyage transocéanique, on observe une activation de la glande thyroïde (3). Nous nous demandions si cette activation était un phénomène particulier à l'espèce ou s'il pouvait être retrouvé chez les autres poissons amphibiotiques, au moment du retour à la mer. Avec l'aide de Mr. V i b e r t, nous avons pu nous procurer dans le Gave d'Oloron de jeunes saumons de descente, des smolts, possesseurs à ce stade d'une très belle robe argentée, et nous avons trouvé là encore, une activation thyroïdienne par rapport à la thyroïde du parr ou tocan, c'est-à-dire du jeune saumon sédentaire[1]). Donc, chez deux migrateurs amphibiotiques, cependant très différents comme l'anguille et le saumon, nous retrouvons, au moment de l'avalaison, un même phénomène endocrinien, "l'activation thyroïdienne", ce qui nous donne à penser que nous sommes peut-être en présence de l'un des facteurs de ce dénominateur commun du mécanisme des migrations auquel je faisais allusion plus haut.

En raison des réserves qui viennent d'être faites, il est utile d'orienter aussi les recherches vers la biochimie des tissus et du milieu intérieur, qui est dans certains cas capable de représenter plus fidèlement l'ensemble de la fonction endocrinienne. Le dosage de l'hormone elle même ou du groupement prosthétique de cette hormone dans les tissus, dans le sang, apparaît la solution la plus rationnelle, mais il faut bien dire qu'elle se heurte encore, pour la plupart des hormones, à des difficultés insurmontées et qu'elle reste, même quand elle semble résolue, d'une

[1]) Résultat en accord avec celui obtenu en Amérique par W. S. H o a r et dont nous n'avons pu prendre connaissance que récemment.

technique très délicate? De plus, en ce qui concerne la teneur en hormone du sang, une valeur élevée n'implique pas nécessairement un hyperfonctionnement endocrinien, mais peut aussi résulter d'un "appetit" très faible des tissus pour l'hormone. Inversement, il est arrivé qu'on signale des teneurs très basses en hormone dans le sang, avec un hyperfonctionnement endocrinien évident[1]), parceque l'avidité des tissus était au contraire extrême. Il faut donc interpréter ces résultats avec prudence. De plus, il semble bien que certaines hormones circulent par voie nerveuse et non sanguine (neurocrinie hypophysaire) (C o l l i n).

Il est encore possible, comme on le fait si souvent dans les études endocrinologiques portant sur les mammifères, de chercher dans le sang la valeur d'éléments étrangers à l'hormone elle-même, mais dont les variations apparaissent caractéristiques d'une déficience ou d'un hyperfonctionnement endocrinien; c'est le cas, par exemple, du rapport Na/K représentatif du fonctionnement cortico surrénalien, des liens qui unissent la calcémie à l'activité parathyroïdienne, etc. . . ; on pourrait multiplier ces exemples. Je signalerai simplement que récemment, nous avons pu établir aussi bien chez les poissons que chez les mammifères, le rapport étroit existant entre la cuprémie et l'activité thyroïdienne et surrénalienne (F o n t a i n e et L e l o u p). Si l'on procède à l'ablation de la thyroïde ou au blocage chimique de la fonction thyroïdienne, on observe une chute importante du cuivre sanguin. Mais si, dans le même temps, on donne à l'animal de la thyroxine, la cuprémie ne descend pas. D'autres hormones, comme les hormones hypophysaires, n'ont aucune influence tandis que l'adrénaline agit dans le même sens que la thyroxine. Soulignons qu'on ne peut prétendre que les variations de la cuprémie sont la conséquence d'une élévation du métabolisme, car l'action du dinitrophénol est sans effet sur la cuprémie. Il semble donc bien ressortir de ces recherches expérimentales qu'il existe une relation étroite entre la cuprémie et l'activité thyroïdienne et médullo-surrénalienne. Voyons maintenant un exemple dans le domaine qui nous intéresse plus spécialement aujourd'hui. Si nous comparons la cuprémie du jeune saumon parr à celle du smolt, nous trouvons pour le premier des valeurs comprises entre 39 et 44 γ, et entre 48 et 58 γ pour le second dont la glande thyroïde est en hyperfonctionnement par rapport au premier. Dans ce cas, nous avons donc un accord parfait entre l'histologie de la glande et une donnée biochimique sanguine. D'autres mesures ont été faites chez plusieurs poissons amphibiotiques au cours de la migration, déterminations qui semblent donner des résultats intéressants et seront publiés ultérieurement. Je crois que des méthodes de ce type ne se suffisent pas à elles mêmes, mais qu'elles peuvent étayer utilement les résultats apportés par la méthode histologique. Un accord des deux méthodes consolide l'opinion que nous nous étions faite par la première. Un désaccord nous conduit à poursuivre la recherche par d'autres voies. Quelles sont-elles?

Je passerai rapidement sur les techniques qui consistent à injecter

[1]) C'est précisément ce qu'on observe chez le smolt (F o n t a i n e, L e l o u p et O l i v e r e a u, travaux en cours). Note ajoutée à la correction des épreuves.

des hormones synthétiques ou naturelles, et qui sont employées déjà depuis longtemps, avec des fortunes très diverses. Ainsi, depuis que j'ai montré (5) qu'on pouvait obtenir par quelques injections de prolan la maturation génitale complète de l'anguille mâle, certains auteurs ont pu confirmer ce résultat, mais d'autres — récemment encore — n'ont pu le reproduire. Il n'entre pourtant dans ces expériences aucun coefficient personnel de l'opérateur. Mais dans cette direction, nous travaillons encore bien trop souvent dans le brouillard. Nous ne savons pas si l'hormone employée — extraite fréquemment des mammifères — est identique à celle que les poissont fabriquent, ou si, avec le corps injecté qui n'est parfois que le squelette de l'hormone véritable (une prohormone) les poissons seront capables de synthétiser celle qui leur est propre. Une hormone étrangère, même distincte seulement par des caractères très subtils et secondaires, peut fort bien jouer le rôle d'antigene, et déclancher la formation d'antihormones qui produisent le résultat exactement inverse de celui attendu. De plus nous n'avons dans la majorité des cas, qu'une idée très approximative de la production quantitative normale de telle ou telle hormone chez une espèce de poisson, et nous risquons que des doses trop fortes et répétées n'entraînent la production de ces antihormones, comme l'a soutenu Collip et son école pour les mammifères. Ainsi, nous devons donc faire appel à ces techniques, mais ne pas considérer leur verdict comme décisif, surtout si celui-ci est negatif.

Un autre mode d'exploration couramment pratiqué chez les animaux supérieurs, est l'exérèse chirurgicale, mais son emploi est beaucoup plus limité chez les poissons que chez les autres vertébrés. Nous pouvons évidemment hypophysectomiser un poisson, mais comme l'hypophyse retentit, et d'une manière capitale, sur toutes les fonctions endocriniennes, cette opération revient à les perturber toutes, et l'interprétation des résultats devient difficile. La même objection ne se pose pas pour la thyroïde par exemple. Mais nous nous heurtons là chez les téléostéens à une impossibilité anatomique: la thyroïde s'y présente sous forme non d'un organe nettement individualisé, mais au contraire très dispersé. De même pour les cortico et médullo surrénales. Enfin, nous n'atteignons ainsi que la glande endocrine, et non sans doute la fonction endocrinienne, qui doivent être nettement distinguées pour les raisons indiquées plus haut. Et c'est ce qui me conduit à vous dire quelques mots d'une dernière méthode récente qui a le grand mérite pour nous, d'atteindre la fonction endocrinienne globale: je veux citer le blocage chimique d'une synthèse hormonale.

En effet, la découverte de l'action antithyroïdienne des composés soufrés (dérivés de la thiourée, aminothiazol) qui agissent sur l'organisme comme s'ils rendaient impossible la synthèse de la thyroxine, nous apporte un nouveau mode d'investigation des fonctions endocriniennes, particulièrement précieux vis à vis des téléostéens. Il fallait d'abord vérifier que ces corps antithyroïdiens experimentés chez les Homéothermes sont également actifs chez les poissons. C'est ce que nous avons

fait dans mon laboratoire et, ce point acquis, nous pouvons imaginer des expériences très variées où cette technique sera susceptible de nous apporter des données intéressantes. Voyons un exemple des recherches qu'elle peut susciter: vous savez que les jeunes anguilles qui arrivent dans nos estuaires, présentent des signes histologiques nets d'activité thyroïdienne, au moins pour la majorité des individus, et l'on s'est demandé si ce n'est pas cette activité thyroïdienne qui conditionne, *pro parte,* le rhéotropisme positif des individus remontant le cours des fleuves. Ayant eu à ma disposition, au printemps dernier, des civelles à cette étape de leur migration, nous avons d'abord trié les individus qui présentaient un rhéotropisme positif très net et les avons séparés en deux lots, l'un, témoin, gardé dans l'eau douce, l'autre dans une solution de phénylthiourée à 1 pour dix mille. Au bout de quelques jours alors que le lot témoin comprenait encore 90 % de civelles à rhéotropisme positif, le lot immergé dans le bain de phénylthiourée ne présentait qu'un pourcentage de ces même civelles de 20 %. Ces premiers résultats, inédits, doivent être évidemment vérifiés au printemps prochain sur des civelles provenant de diverses régions. Il est possible que, par des variations de doses, de durée, nous parvenions à inhiber totalement le rhéotropisme positif, mais, dans le cas contraire, et si le résultat ci-dessus est confirmé, il signifiera simplement que l'activité thyroïdienne est un facteur important du rhéotropisme positif, mais qu'il n'est pas le seul facteur, ce qu'on peut aisément prévoir, la sécrétion d'adrénaline soit d'origine sympathique, soit d'origine médullo surrénale jouant sans doute également un rôle important. Une autre substance a été découverte ces dernières années, l'alloxane, qui peut bloquer la sécrétion insulinienne et provoquer un véritable diabète. Certains corps chimiques antihypophysaires sont actuellement à l'étude et il est inutile de souligner l'intérêt de substances qui permettraient d'inhiber telle ou telle fonction hypophysaire.

Cet exposé est loin d'être complet. J'aurais dû noter également les possibilités que nous offre la technique des éléments marqués, technique qui n'est malheureusement pas à la disposition de nombreux laboratoires, surtout des laboratoires maritimes, mais qui pourrait nous donner des renseignements extrêmement précieux sur la genèse des hormones dans l'organisme. Je me contenterai seulement d'insister sur le fait que dans ce domaine, nous ne pouvons aboutir à des résultats sûrs que par l'emploi coordonné de ces diverses techniques, s'épaulant les unes les autres.

Et, avant de conclure, je voudrais émettre quelques remarques sur les idées que je viens de vous soumettre. Nous sommes en effet contraints, pour comprendre et pour exposer une question aussi complexe que celle ci, de la disséquer, d'en isoler les divers éléments, et souvent, par là même, de trahir plus ou moins la vérité. C'est ainsi que j'ai présenté, au début de cet exposé, les facteurs internes comme étant dans le déclanchement de la migration et par rapport aux facteurs externes, des facteurs primaires. Je crois que, d'un point de vue général, ceci est exact, mais je dois cependant apporter une restriction à cette manière

de voir, et réhabiliter dans une certaine mesure, les facteurs externes: les hiérarchies naturelles, comme d'ailleurs les hiérarchies sociales, peuvent aisément s'inverser. On sait que la température, par exemple, peut agir sur l'intensité de fonctionnement de certaines glandes de poecilothermes. Voici donc un facteur externe qui peut agir sur un facteur interne pour en modifier l'intensité fonctionnelle. Cette variation du facteur interne agira par la suite pour sensibiliser le poisson à certains facteurs externes. Il n'en reste pas moins que, dans le cas où une variation de température par exemple déclancherait une migration d'une espèce donnée par l'intermédiaire de glandes endocrines sans produire aucun effet sur les espèces sédentaires voisines, il faudrait attribuer cette différence de comportement à des différences de sensibilité des glandes considérées aux facteurs externes.

Certaines migrations (et je pense actuellement sourtout à la migration catadrome du jeune saumon) s'effectuent avec une soudaineté et une ampleur telles, elles portent sur un nombre si considérable d'individus, qu'il est bien improbable que ceux-ci soient tous parvenus, le même jour, à un stade bien défini d'activité endocrinienne, mais il apparaît plus vraisemblable qu'une hyperactivité endocrinienne les a mis dans un état de réceptivité vis-à-vis de certaines modifications cosmiques qui représentent comme l'étincelle mettant le feu aux poudres. Les variations fonctionnelles des glandes endocrines ne joueraient alors qu'un rôle de sensibilisation de l'organisme vis-à-vis de facteurs externes.

Enfin, j'ai donné, chemin faisant, quelques exemples pris à la fonction thyroïdienne. Je ne voudrais pas que ce choix soit interprété comme une tendance de l'auteur à considérer la glande thyroïde comme la glande endocrine majeure des migrations. Ce choix m'a été dicté par le fait que la glande thyroïde est actuellement la mieux connue, celle dont le fonctionnement est le plus aisément exploré. Mais, je suis persuadé que tout le système endocrinien participe au déterminisme de ces migrations, et je pense qu'il faudrait même plutôt dire tout le système neuro-endocrinien qui représente ce qu'on a nommé, pour l'homme, la forteresse de la personnalité, et qui est sans doute pour le poisson, la forteresse de l'individualité.

Je crois que c'est pour une grande part dans la qualité de cette forteresse qu'il faut chercher les raisons pour lesquelles certains saumons restent en rivière un an, d'autre deux ans, d'autre trois ans, pourquoi certains sont des migrants précoces et d'autre tardifs: de même en ce qui concerne la montée. Certains auteurs prétendent[1]) que la durée de la vie du parr en eau douce retentit sur la durée de vie du saumon en mer. Mais, plutôt qu'une action directe de la vie fluviale sur la vie marine, ne pourrait on pas envisager que ces deux étapes sont en réalité commandées par des caractères physiologiques communs et surtout par ce complexe neuro-endocrinien qui imposerait, à certains individus une croissance relativement lente en eau douce et une longue vie fluviale avec un

[1]) Opinion soutenue par Calderwood, discutée par Kendall.

bref séjour en mer (remontée à l'état de grilse), à d'autres individus, des conditions éthologiques inverses. Cette hypothèse, relative au saumon, pouvant être évidemment transposée à certains caractères présentés par diverses variétés d'autres espèces. Une telle hypothèse suggère évidemment un ensemble de recherches considérable, mais qui nous apporteront sans doute sur la biologie des poissons des données assez importantes pour justifier le labeur qu'elles imposent.

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Lemon Soles at Iceland, 1924—1939, with Special Reference to Faxa Bay.

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Introduction and Material.

ACCORDING to the *Bulletin Statistique* the Icelandic area ranks second in importance to the North Sea as a source of lemon sole landings. From 1932 to 1937 it contributed the following quantities to the grand totals of lemon soles landed by the fishing vessels of all countries from the North-East Atlantic.

Year	1932	1933	1934	1935	1936	1937
Weight of lemon soles in '000 kilo	2416	2201	2368	2366	2719	3003
Percentage of totals from all areas	23·9	23·3	25·6	24·4	28·5	31·8

These figures demonstrate a marked increase in the results of the lemon sole fishery at Iceland within a few years so that it is of some interest to examine the results over a longer period. For this purpose reference is made to the English and Scottish fisheries statistical tables, which, combined, give the total British catch. It is known from the *Bulletin Statistique* that the catch of lemon soles by British vessels forms from 86 per cent. to 90 per cent. of the total European catch, so it may be accepted that the British catch reflects fairly closely the fishery as a whole. Table 1 gives the weight in cwt. of lemon soles caught by

Table 1.

Year	1922	1923	1924	1925	1926	1927	1928	1929	1930
Cwt.	7,551	12,057	10,657	9,114	13,911	23,956	29,847	28,746	26,928
%	10	15	12	10	14	17	21	21	20

Year	1931	1932	1933	1934	1935	1936	1937	1938
Cwt.	32,367	41,165	34,097	37,865	40,335	46,839	53,499	37,762
%	21	23	21	24	24	29	33	25

Chart showing trawling positions of research vessels and number of occasions on on which grounds were sampled 1924—1939 (except in the southern end of Faxa Bay where sampling too frequent to show on chart).
Catches of Lemon Sole: 1: blank; 2: light; 3: medium; 4: heavy.

British vessels at Iceland each year from 1922 to 1938 and also the catch expressed as a percentage of the total British catch from all areas.

The total catch of lemon soles by British vessels from all areas rose steadily from 78,307 cwt. in 1922 to a maximum of 179,209 cwt. in 1932, since when it has never fallen below 150,000 cwt. This indicates an increase of more than 100 per cent. The landings from Iceland, however, in rising from 7,551 cwt. in 1922 to 53,499 cwt. in 1937 show an increase of over 700 per cent. During the period under review no other area shows such an improvement. Prior to 1927 the Icelandic landings were exceeded by those from Faroe, but every year since then, with the exception of 1931, landings from Iceland have been greater than those from Faroe.

No detailed information is available regarding the exact localities at Iceland from which the catches are procured. This can be known approximately, however, from our knowledge of the distribution of the species.

According to S a e m u n d s s o n (3 b) lemon soles "are fairly numerous in the warmer water on the SE., S. and W. coasts" of Iceland. Off the western half of the north coast they are "not uncommon", but are rare further east. Recent fishery investigations, based on the cruises of research vessels and on general information relating to commercial operations, fully confirm this statement of the distribution of the species at Iceland.

Although scientific research in Icelandic waters has been in progress for many years and almost continuously since 1924, there have been few complete surveys of the grounds round the island. Trawling operations on all grounds have been very spasmodic, with the exception of Faxa Bay, which has received particular attention in the Danish investigations. As may be expected, therefore, the bulk of the lemon sole material, supplied by Dr. T å n i n g of Denmark, which forms the basis of the present report, consists of data from the Faxa Bay area. It is thus possible to give a fairly comprehensive account of the species in this region, while referring more briefly to other regions.

The material consists of measurements, sex determinations, maturities and scale samples of lemon soles caught by means of the otter trawl over the period 1924—1939. Most of the data is the result of work by the Danish and Icelandic research ships "Dana" and "Thor", but supplementary information is also available from cruises by the "Explorer" of Scotland (1925), the "George Bligh" of England (1936) and the "Nautilus" of Holland (1936—37). Throughout the Danish and most of the Icelandic investigations the gear in regular use was the 50-foot otter trawl, while various modifications of the commercial trawl were mainly employed on the other vessels.

Division of Lemon Sole Grounds at Iceland.

From a consideration of the place of origin of the material, it was decided to deal with the following regions or localities separately:—

1. Faxa Bay; 2. Reykjanes; 3. Vestmann Isles; 4. Portland; 5. Ingolfshöfdi; 6. NW., N. and E. coasts (see accompanying chart).

Owing to the irregular nature of the sampling, few figures can be given to illustrate the importance of these localities from the point of view of population. It is clear that at definite places along the south-west and south coasts dense populations are located, but it is doubtful if these dense populations are continuous. On the contrary the results of the "Explorer" cruise in 1925 suggest a number of thickly populated patches separated by grounds on which lemon soles are less numerous or even absent.

1. Faxa Bay.

Distribution. Lemon Soles are found throughout Faxa Bay, with the exception perhaps of the north-east corner, where repeated blank hauls have been made. Most of the sampling has been carried out in the shallow water (30—40 metres) of the southern section of the bay, where the population appears to be most dense. Good hauls have also been made in the Jökuldjup, in the central and outer part of the bay, at depths of 150 metres. The results of regular sampling at positions within and without territorial limits in the southern half of the bay are given in Table 2.

Table 2.
Numbers of Lemon Soles caught per 10 hours' fishing in southern section of Faxa Bay.

Year	Month	Vessel	Gear	Territorial	Extra-Territorial
1924	June—July	Dana	50′ O.T.	154	39
1925	June	Explorer	50′ O.T.	100	—
	June	Explorer	Comm. Trawl	840	140
	July—Aug.	Dana	50′ O.T.	93	22
1926	June—July	Dana	50′ O.T.	71	1
1927	March	Thor	50′ O.T.	4	0
	April	Thor	50′ O.T.	22	4
	July—Aug.	Dana	50′ O.T.	118	5
	October	Thor	50′ O.T.	37	2
1928	February	Thor	50′ O.T.	3	0
	May	Thor	50′ O.T.	31	0
	August	Thor	50′ O.T.	52	1
	October	Thor	50′ O.T.	2	2
1929	February	Thor	50′ O.T.	2	0
	May	Thor	50′ O.T.	42	1
	July	Thor	50′ O.T.	62	8
	October	Thor	50′ O.T.	132	8
1931	July	Dana	50′ O.T.	136	127
1932	July	Dana	50′ O.T.	107	77
1933	August	Dana	50′ O.T.	93	153
1934	May	Dana	50′ O.T.	45	52
1936	June	Nautilus	Comm. Trawl	175	180
	July	George Bligh	Comm. Trawl	1880	1020
	July	Thor	Comm. Trawl	454	—
1937	May	Thor	Comm. Trawl	496	224
	May	Nautilus	Comm. Trawl	205	60
	October	Thor	Comm. Trawl	248	8
1938	February	Thor	Comm. Trawl	74	1
	June	Thor	Comm. Trawl	663	180
	July	Dana	50′ O.T.	301	49
	December	Thor	Comm. Trawl	234	1
1939	July	Dana	50′ O.T.	342	57

A number of features may be noted from a study of this table. In the first place it is seen that larger catches are obtained during the summer months, from May to August, than at other times. This, however, is not peculiar to this region but is characteristic of the lemon sole fishery on other Icelandic grounds, at Faroe and in the North Sea.

Secondly, the numbers caught per 10 hours' fishing in all but a few instances are greater in territorial waters than in extra-territorial waters.

Thirdly, between 1924 and 1929 a steady decline occurs in the numbers of lemon soles taken per unit of fishing time. In 1931 there follows a sudden increase which is maintained until 1939, when the

Table 3.
Size Frequencies of Lemon Soles caught in Faxa Bay by Research Vessels.

	< 21 cm.	21—25 cm.	26—30 cm.	31—35 cm.	36—40 cm.	41—45 cm.	46—50 cm.	Totals
1924	20	161	206	134	119	61	5	706
% of total	2·8	22·8	29·3	19·0	16·9	8·6	0·7	
1925	2	24	114	95	56	20	1	312
% of total	0·6	7·7	36·5	30·5	18·0	6·4	0·3	
1926	2	21	83	69	30	22	—	227
% of total	0·9	9·2	36·6	30·4	13·2	9·7	—	
1927	—	17	75	149	86	46	1	374
% of total	—	4·6	20·1	39·8	23·0	12·3	0·2	
1931	79	120	144	108	47	25	1	524
% of total	15·1	22·9	27·5	20·6	8·9	4·8	0·2	
1932	27	111	110	51	15	13	1	328
% of total	8·2	33·8	33·5	15·6	4·6	4·0	0·3	
1933	21	65	127	33	20	6	3	275
% of total	7·6	23·6	46·2	12·0	7·3	2·2	1·1	
1934	2	23	16	10	6	3	1	61
% of total	3·3	37·7	26·2	16·5	9·8	4·9	1·6	
1935	1	17	49	26	5	2	—	100
% of total	1·0	17·0	49·0	26·0	5·0	2·0	—	
1936	220	293	402	198	52	24	—	1189
% of total	18·5	24·6	33·8	16·7	4·4	2·0	—	
1937	6	153	179	51	61	44	10	504
% of total	1·2	30·4	35·5	10·1	12·1	8·7	2·0	
1938	80	183	191	53	23	6	1	537
% of total	14·9	34·1	35·5	9·9	4·3	1·1	0·2	
1939	3	27	152	49	8	—	—	239
% of total	1·3	11·3	63·6	20·5	3·3	—	—	

numbers per 10 hours' fishing with the 50-ft. otter trawl are actually the highest recorded from territorial waters during the whole period.

Length Measurements. Considerable variation occurs in the size frequencies throughout the period under review (*vide* Table 3).

From 1924 to 1927 the numbers in the smallest size groups in Faxa Bay decline steadily so that few lemon soles of less than 26 cm. are found in the 1927 records. This poor recruitment naturally results in an increase in the average size of the stock and, although the numbers of larger fish are well maintained up to 1927 at least, the reduction in the numbers of fish caught per unit of fishing time, noted on Table 2,

Table 4. Age Analysis of Lemon Soles from Faxa Bay.

Age-Groups
(The serrated lines connect age-groups of equal age; the vertical lines headed by Roman figures give *consecutive* years)

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	Totals
1939 Number	—	—	0	23	107	73	14	7	11	1	2	1	—	—	—	—	—	—	239
%	—	—	0·0	9·6	44·8	30·6	5·9	2·9	4·6	0·4	0·8	0·4	—	—	—	—	—	—	
1938 Number	—	2	63	138	139	40	8	28	4	12	4	4	4	—	3	—	—	—	449
%	—	0·5	14·0	30·7	31·0	8·8	1·8	6·3	0·9	2·7	0·9	0·9	0·9	0·0	0·6	—	—	—	
1937 Number	0	0	37	78	50	18	28	8	6	5	3	—	—	—	—	—	—	—	233
%	0·0	0·0	15·9	33·5	21·5	7·7	12·0	3·4	2·6	2·1	1·3	—	—	—	—	—	—	—	
1936 Number	0	8	111	98	38	190	21	41	14	10	6	2	6	2	0	2	—	—	549
%	0·0	1·5	20·2	17·8	6·9	34·6	3·8	7·5	2·5	1·8	1·1	0·4	1·1	0·4	0·0	0·4	—	—	
1935 Number	0	0	2	3	31	8	29	15	5	1	1	2	0	2	0	1	—	—	100
%	0·0	0·0	2·2	3·0	31·0	8·0	29·0	15·0	5·0	1·0	1·0	2·0	0·0	2·0	0·0	1·0	—	—	
1934 Number	0	0	0	15	8	14	3	1	2	0	6	1	0	1	—	—	—	—	51
%	0·0	0·0	0·0	29·4	15·7	27·5	5·9	20·	3·9	0·0	11·8	1·9	0·0	1·9	—	—	—	—	
1933 Number	0	2	37	18	128	38	12	10	3	13	3	1	5	0	1	2	—	—	273
%	0·0	0·7	13·6	6·6	46·9	13·9	4·4	3·7	1·1	4·7	1·1	0·4	1·8	0·0	0·4	0·7	—	—	
1932 Number	0	8	15	117	101	36	10	5	10	8	3	8	1	2	4	—	—	—	328
%	0·0	2·4	4·6	35·7	30·8	11·0	3·1	1·5	3·1	2·4	0·9	2·4	0·3	0·6	1·2	—	—	—	
1931 Number	1	10	91	107	108	47	7	32	8	10	42	13	7	10	4	2	1	—	500
%	0·2	2·0	18·2	21·4	21·6	9·4	1·4	6·4	1·6	2·0	8·4	2·6	1·4	2·0	0·8	0·4	0·2	—	
— —	-	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
1927 Number	—	—	0	24	0	6	116	63	13	24	18	46	24	13	12	5	3	—	367
%	—	—	0·0	6·6	0·0	1·6	31·6	17·2	3·5	6·5	4·9	12·5	6·5	3·5	3·3	1·4	0·9	—	
1926 Number	—	0	3	0	0	97	35	6	12	6	19	11	10	14	6	3	3	—	225
%	—	0·0	1·3	0·0	0·0	43·1	15·6	2·7	5·3	2·7	8·5	4·9	4·4	6·2	2·7	1·3	1·3	—	
1925 Number	0	0	0	0	59	60	8	10	4	12	9	11	14	8	6	5	2	1	209
%	0·0	0·0	0·0	0·0	28·2	28·7	3·8	4·8	1·9	5·7	4·3	5·3	6·7	3·8	2·9	2·4	1·0	0·5	

is therefore most pronounced in the smaller size-groups. From 1931 onwards the smallest fish are well represented in the catches although periods of relative scarcity occur in 1935 and 1939.

In addition to these fluctuations in the frequencies in the 5 cm. groups another change is remarkable in the decline in the numbers of the larger fish caught per unit of fishing time from 1927 onwards. For example, the numbers of lemon soles from 41 to 45 cm. caught per 10 hours' fishing falls from 7 in 1927 to less than 2 in 1938 and finally, in 1939, fish of this size category disappear completely from the records. The high percentages of larger fish in 1937 are somewhat misleading since they are due to the sampling of new grounds in Jökuldjup, which are much less intensively fished commercially and which have not been regularly included in the research programmes.

Age Determination. Age determination is carried out entirely by means of scale examination. When scales are obtained from the proper position on the body of the lemon sole (the lateral line about two-thirds of the length backwards from the snout) little difficulty is encountered in deciding the age of the fish. Occasionally, however, the small scale-increments in older fish render the determination of the correct age rather difficult, especially if associated with false rings or checks in the scale growth. It must be admitted, therefore, that some doubt exists regarding the age of a small percentage of fish of ten years of age and over. This, however, in no way alters the general truth of the statements on age analysis.

The age analyses of the catches of the research vessels are given in Table 4. During the period under review eighteen different age-groups are represented in the catches, ranging from 1+ to 18+ years of age, although in recent years there is a tendency for the number of age-groups to diminish. In the 1+ group there is only a single record, measuring 7·4 cm., which was obtained in 1931 in extra-territorial waters. Even 2+ fish are remarkably scarce, especially if the numbers are compared with those of the same age taken at Faroe and in the North Sea. Thus any attempt at forecasting the strength of any brood is impossible, with the present method of sampling, before the fish are 3 or 4 years of age.

From a study of the percentages of the different broods making up the annual catches it is possible to ascertain, to some extent, the relative strengths of the broods and to trace their influence in the maintenance of the stock.

A glance at the figures for the earlier years of the period explains the scarcity of small fish referred to in the last section. This is due to the complete failure of the 1921 and 1922 broods in the southern half of Faxa Bay and to their consequent absence from the catches a few years later, at a time when they should, normally, be making their appearance in good numbers. From 1931 onwards both these broods are present in very small proportions but this may be due to immigration. In addition to the failure of the 1921 and 1922 broods, those

Table 5.

Size Frequency of Lemon Soles from Territorial and Extra-Territorial Positions in Faxa-Bay.

		<21 cm.	21—25 cm.	26—30 cm.	31—35 cm.	36—40 cm.	41—45 cm.	46—50 cm.	Totals
1924, June—July									
Terri-	Number	11	109	145	100	98	37	4	504
torial	%	2·2	21·6	28·8	19·8	19·5	7·3	0·8	
Extra-	Number	9	52	59	32	20	23	1	196
terr.	%	4·6	26·5	30·1	16·3	10·2	11·8	0·5	
1931, July									
Terri-	Number	52	88	64	42	18	7	—	271
torial	%	19·2	32·5	23·6	15·5	6·6	2·6	—	
Extra-	Number	27	32	80	66	29	18	1	253
terr.	%	10·7	12·7	31·6	26·1	11·4	7·1	0·4	
1932, July									
Terri-	Number	10	50	23	12	7	5	—	107
torial	%	9·4	46·7	21·5	11·2	6·5	4·7	—	
Extra-	Number	16	60	87	39	8	8	1	219
terr.	%	7·3	27·4	39·7	17·8	3·7	3·7	0·4	
1933, August									
Terri-	Number	—	20	61	16	7	3	—	107
torial	%	—	18·7	57·0	15·0	6·5	2·8	—	
Extra-	Number	21	45	66	17	13	3	3	168
terr.	%	12·5	26·8	39·3	10·1	7·7	1·8	1·8	
1936, June—July									
Terri-	Number	145	171	170	111	42	19	—	658
torial	%	22·0	26·0	25·8	16·9	6·4	2·0	—	
Extra-	Number	55	96	191	60	5	1	—	408
terr.	%	13·5	23·5	46·8	14·7	1·2	0·3	—	
1938, July									
Terri-	Number	75	171	164	36	10	5	1	462
torial	%	16·2	37·0	35·5	7·8	2·2	1·1	0·2	
Extra-	Number	5	11	26	11	2	—	—	55
terr.	%	9·1	20·0	47·3	20·0	3·6	—	—	

of 1923, 1924, and 1925 are all poor or of poor-medium strength, thus rendering the scarcity of lemon soles still more acute — a condition which is reflected in the extraordinarily small numbers taken per 10 hours' trawling in 1928—29 (*vide* Table 2).

The appearance of large numbers of small fish from 1931 to 1938 is clearly the result of the emergence of a number of prolific year-classes. Although the reduction in the numbers of older and larger fish caught per unit of fishing time during this period is no doubt due in part to intensity of commercial trawling, it is also due in some measure to a scarcity of older and larger fish, as a result of the period of poor

Table 6.
Age Frequency of Lemon Soles from Territorial and Extra-Territorial Positions of Faxa Bay.

	Year	1931 July		1932 July		1933 August		1936 June/July		1938 July	
	Month	Terr.	Extra.	Terr.	Extra.	Terr.	Extra.	Terr.	Extra.	Terr.	Extra.
–3+	Number	67	24	9	14	5	34	109	10	57	4
	%	25·7	10·5	8·4	6·4	4·7	20·5	25·7	8·0	19·0	7·4
	Number	61	46	41	74	8	10	66	32	95	12
	%	23·4	20·2	38·3	33·8	7·5	6·0	15·6	25·4	31·6	22·2
	Number	56	52	24	77	52	76	24	14	92	17
	%	21·4	22·8	22·4	35·1	48·6	45·8	5·9	11·1	30·6	31·5
	Number	10	37	11	25	21	17	128	62	23	10
	%	3·9	16·2	10·3	11·4	19·6	10·3	30·2	49·2	7·6	18·5
	Number	4	13	3	7	8	4	19	2	3	2
	%	1·5	1·3	2·8	3·2	7·5	2·4	4·5	1·6	1·0	3·7
	Number	21	11	2	3	3	7	37	4	14	8
	%	8·1	4·8	1·9	1·4	2·8	4·2	8·7	3·1	4·6	14·8
	Number	4	4	6	4	1	2	14	—	2	—
	%	1·5	1·8	5·6	1·8	0·9	1·2	3·3	—	0·7	—
–12+	Number	28	37	9	10	7	10	17	1	11	1
	%	10·7	16·2	8·4	4·6	6·6	6·0	4·0	0·8	3·6	1·9
–15+	Number	9	12	2	5	1	5	8	—	4	—
	%	3·4	5·3	1·9	2·3	0·9	3·0	1·9	—	1·3	—
–18+	Number	1	2	—	—	1	1	1	1	—	—
	%	0·4	0·9	—	—	0·9	0·6	0·2	0·8	—	—
	Number	261	228	107	219	107	166	423	126	301	54
	%	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0

recruitment from 1921 to 1925. This fact, in conjunction with the appearance of four prolific broods within the period 1928—34, is also the cause of the remarkable fall in the average size of the stock.

In the light of experience derived from a study of lemon soles at Faroe and in Scottish waters, it is possible from Table 4 to make a rough classification of the broods according to their relative strengths in Faxa Bay. The following grouping of the broods may be suggested:

Good	1920, 1928, 1930, 1933, 1934
Medium — Good	1919, 1926, 1927, 1932
Medium — Poor	1923, 1925, 1929, 1935
Poor	1921, 1922, 1924, 1931

Comparison of Territorial and Extra-Territorial Stocks. Considering the importance of the records from territorial and extra-territorial waters, some comparison of the two positions sampled is of interest, particularly in view of the conditions and regulations relating to fishing in the bay. For convenience the data for the most heavily sampled years are set forth in Table 5 (Size) and Table 6 (Age).

Tables 5 and 6 show that in size and age the lemon soles of territorial waters differ little from those of extra-territorial waters. There is a tendency for the proportions of larger and older fish to be slightly greater at extra-territorial positions but this does not apply in every

Table 7.
Average Size of Lemon Soles in Faxa Bay — Caught 21st June to 21st August 1925—39.

Age	Territorial				Extra-Territorial			
	Number	Range cm.	Mean cm.	Incr. cm.	Number	Range cm.	Mean cm.	Incr. cm.
1+	—	—	—	—	1	—	7·4	—
2+	9	12—14	13·4	—	21	11—16	13·4	6·0
3+	241	13—24	19·5	6·1	75	14—25	19·7	6·3
4+	304	18—30	23·8	4·3	183	20—30	24·4	4·7
5+	401	20—34	27·3	3·5	249	20—35	27·8	3·4
6+	407	23—37	29·3	2·0	171	20—39	29·9	2·1
7+	189	25—38	31·2	1·9	29	27—38	31·9	2·0
8+	152	27—40	33·1	1·9	41	26—38	33·6	1·7
9+	66	27—41	34·3	1·2	11	28—41	35·0	1·4
10+	68	27—43	36·0	1·7	21	28—47	37·5	—
11+	75	28—44	36·6	0·6	26	27—42	36·3	—
12+	80	31—45	37·9	1·3	16	34—45	39·7	—
13+	60	29—45	39·1	1·2	8	33—48	40·9	—
14+	43	30—44	38·8	—	6	36—43	41·2	—
15+	26	30—46	40·9	—	10	33—47	41·7	—
16+	16	33—45	40·8	—	3	41—46	43·3	—
17+	8	33—45	40·5	—	1	—	45·0	—

case. As regards the youngest fish the numbers of 2+ and 3+ fish in territorial waters exceed those from the extra-territorial position in 1931 and 1938 but in 1924 and in 1933, the reverse conditions prevail and the youngest age-groups are more numerous in extra-territorial waters. It would appear, therefore, that neither in their size frequencies per 5 cm. groups, nor in their age composition do the lemon sole stocks of territorial waters differ in any essential or permanent manner from those of extra-territorial waters.

Growth. The growth of lemon soles from Faxa Bay is studied in the same manner as those from Faroe and the North Sea by directly combining the age determinations and measurements to arrive at averages. Most of the samples are from the month of July but in view of the slow growth-rate and wide range in the size of fish of each age-group, samples from the end of June and the beginning of August are also included. Again, only records from the territorial and extra-territorial positions are used and, for comparison, these are considered separately (*vide* Table 7 and Figure 1).

It is found that the average sizes for territorial waters are slightly smaller in almost every age-group. Up to 13 years of age the average amount by which the extra-territorial figures exceed the territorial figures is about 0·8 cm.

Comparatively few scale samples have been obtained from stations in Faxa Bay other than the fixed territorial and extra-territorial stations. In September 1935 one hundred lemon soles were scaled on board the

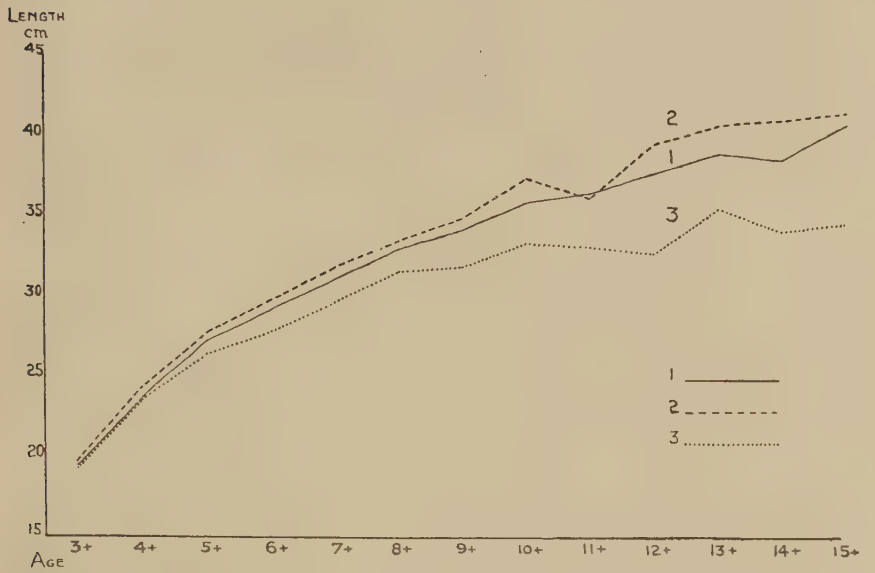

Figure 1. Lemon Sole growth in Faxa Bay. Average sizes of the various age-groups 21st June—21st August 1925—1939.
1. Territorial: *2.* Extra-territorial: *3.* Males (territorial).

Icelandic trawler "Geir" from the position 64°20′N., 22°33′W. to 64°22′N., 22°49′W. The age composition of these fish is given in Table 4 and the following average sizes have been calculated:—

Age	5+	6+	7+	8+	9+
Number	31	8	29	15	5
Range (cm.)	23—32	23—31	21—34	27—38	27—42
Av. Size (cm.)	26·4	27·0	29·3	30·9	33·2

These figures suggest a growth-rate slightly inferior to that found in the southern section of the bay. On the other hand, a few scales from the Jökuldjup in February 1938 indicate that the average sizes for each age-group in this locality may even be higher in the older age-groups than in the southern half of the bay. This is understandable, having regard to the fact that the Jökuldjup would at all times be less intensively fished than inshore grounds.

In comparison with the growth of lemon soles at Faroe and in the North Sea the growth in Faxa Bay is inferior to the very good growth of northern Faroese grounds, but is somewhat better than the Sydero type. Up to 7 years of age the Faxa Bay type resembles most closely the Moray Firth type in Scottish waters. After this age, growth is relatively poorer in Faxa Bay. On the whole the rate of growth in Faxa Bay may be regarded as good by standards of lemon sole growth elsewhere.

Table 8.
Average Sizes of Male and Female Lemon Soles in Territorial Waters of Faxa Bay, 21st June to 21st August 1925—1939.

Age	Males Number	Males Range cm.	Males Mean cm.	Females Number	Females Range cm.	Females Mean cm.
3+	116	13—24	19·3	121	15—24	19·7
4+	171	18—30	23·8	132	18—28	23·9
5+	184	22—31	26·5	202	20—34	27·9
6+	162	23—34	27·9	235	25—37	30·2
7+	76	25—35	29·8	112	25—38	32·1
8+	43	27—39	31·7	107	27—40	33·5
9+	24	30—36	32·0	41	27—41	35·6
10+	21	30—38	33·5	44	27—43	37·1
11+	18	28—39	33·3	54	29—44	37·7
12+	22	31—37	32·9	54	35—45	39·9
13+	16	29—45	35·7	38	32—45	40·3
14+	12	30—40	34·3	30	34—44	40·5
15+	4	30—38	34·8	20	39—46	42·2
16+	2	33—34	33·5	12	39—45	41·8
17+	2	33—39	36·0	4	39—45	41·5

Although it is difficult to obtain strictly comparable figures for each year, owing to different times of sampling and to the fact that growth may be delayed, or even less prominent, in certain years, there is little or no evidence of any change in the growth-rate coincident with the changes in the size and age composition of the stocks during the period under observation.

Before leaving the question of growth it is interesting to note the different rates of growth in the sexes. Slight during the first few years of life, this difference becomes more prominent from 6 years of age onwards, until it varies from 5 to 10 cm. in the oldest age-groups (*vide* Table 8 and Figure 1).

Proportions of Sexes. In dealing with Faroese lemon soles (2 c) it was pointed out that the female fish outnumber the males in most samples. This also applies to Faxa Bay. In this instance the data are more numerous and therefore worthy of more detailed investigation. Distinction is again made between territorial and extra-territorial waters and it is found that, in the former, the annual percentages of males vary from 33 to 60 with an average of 42, while the percentages of females vary from 40 to 67 with an average of 58. In extra-territorial waters the corresponding figures for males are 23 to 47, average 37, and for females 53 to 77, average 63. The ratio of males to females is, therefore, relatively greater in territorial waters.

Another feature regarding the proportions of the sexes is seen in examining the proportions at different ages. In the earlier years of life, up to 5+, the males outnumber the females in the majority of samples.

After 6 years of age the females predominate, particularly with advancing age, so that few male fish are found in the oldest age-groups.

There is reason to believe, therefore, that the poorer growth of males and the higher proportions of males in territorial waters are, in some measure, responsible for the slightly poorer growth-rates of the species as a whole within territorial waters although this is probably mainly due to the denser population and the consequent greater competition for food.

Stomach Contents. At the end of July 1939 sixty-three lemon sole stomachs (forty-six from territorial waters and seventeen from extra-territorial waters of Faxa Bay) were collected and preserved on the "Dana" for detailed examination in the laboratory. Table 9 gives the numbers of stomachs in which each phylum, family, or class represented in the food occurs. The results show a close resemblance to those obtained for this species in the North Sea and in Faroese waters. In the first place only three stomachs were found to be empty and all the intestines contained digested food, thus supporting the view that July is one of the chief feeding months for the lemon sole. Then, Polychaeta, Crustacea, Mollusca, Echinodermata, and Coelentera were found to be the principal types preyed upon and of these the Polychaeta occurred in the stomachs with much greater frequency than any of the others. Even the particular families, genera, and species of Polychaeta identified were on the whole the same as those forming the food of this species in the other regions investigated. Thus, among the sedentary Polychaeta, the Terebellidae and Sabellidae were most frequently represented in the stomachs, while the Aphroditidae and Phyllodocidae outnumbered the other families in the errant group of Polychaeta.

The volumetric measurements of the stomach contents also emphasized the outstanding importance of the Polychaeta. In the 20—29 cm. size group they formed 98 % of the total volume of food within territorial waters and 95 % in the sample from extra-territorial waters. In the 30—39 cm. size group, while the frequency of occurrence of Polychaeta still remained high, Crustacea (particularly Decapoda), Mollusca, and Anthozoa occurred more frequently with the result that the volume percentages were altered somewhat in favour of these three types. In this way Polychaeta provided 86 % and Crustacea 12 % of the food in the sample from territorial waters while in a rather unusual sample from extra-territorial waters containing a considerable amount of unrecognizable food material the Polychaeta fell as low as 29 % and the Mollusca and Anthozoa increased to 31 % and 9 %, respectively, of the total volume.

As a result of the fragmentary nature of much of the stomach contents and the consequent action of the digestive juices, identification of the individual species of Polychaeta preyed upon was often difficult. The following genera or species, however, were noted on one or more occasions in the present examination:—

Territorial Waters:— Polychaeta — *Lanice conchilega*, *Polymnia nesidensis*, *Potamilla reniformis* (very common, as many as one hundred

sets of gills having been counted in a single stomach), *Chone* sp.?, *Pomatoceros triqueter, Melinna cristata, Anabothrus gracilis, Ammotrypane aulogaster, Owenia fusiformis, Harmothoe* sp.?, *Phyllodoce* (two different species). Crustacea — *Hyas* sp.?, *Eupagurus* sp.?

Extra-territorial Waters:— Polychaeta — *Nicolea zostericola, Amphitrite* sp.?, *Hydroides norvegica, Pomatoceros triqueter, Nicomache* sp.?, *Pectinaria* (two different species), *Owenia fusiformis, Onuphis conchylega, Phyllodoce* sp.?

The number of stomachs examined from extra-territorial stations is still too small to permit drawing any definite conclusions but there seems to be little doubt that the general food types, both within and without territorial waters, are the same and that any differences which do occur are dependent on the distribution of individual species. It remains to be seen from future investigations whether this statement is applicable throughout the year or not.

2. Reykjanes.

Grounds immediately to the west of Reykjanes peninsula were sampled on one occasion only — in June 1925, when the "Explorer" caught 340 lemon soles in one hour by means of the commercial otter trawl. Five fish were also taken with the Agassiz trawl in a haul of 15 minutes' duration. These records indicate a densely populated area, the extent of which was not determined and of which no verification has since been obtained by research vessels. The following are the details of age determinations and mean sizes:—

Age	5+	6+	7+	8+	9+	10+
Brood	1920	1919	1918	1917	1916	1915
Number	8	29	15	70	39	65
% of Total	2·3	8·4	4·4	20·4	11·3	18·9
Range — cm.	22—27	20—33	25—36	25—39	26—41	27—40
Mean — cm.	23·4	27·1	30·9	33·0	34·2	34·5

Age	11+	12+	13+	14+	15+	16+
Brood	1914	1913	1912	1911	1910	1909
Number	49	26	17	15	9	2
% of Total	14·2	7·6	4·9	4·4	2·6	0·6
Range — cm.	25—46	30—42	28—44	33—44	32—40	39—40
Mean — cm	35·0	35·4	35·8	36·8	37·0	39·5

One noteworthy feature of the age groupings is the high percentage of fish of 8 years of age and over in the catch in which the 1917 and 1915 broods are outstanding. A resemblance to contemporary catches in Faxa Bay is seen in the complete absence of all broods younger than 5 years old. A curve illustrating the growth, as derived from the average sizes of the age-groups, appears in Figure 2.

Table 9.
Lemon Sole Food in Faxa Bay. July 1939.

Position	Territorial				Extra-Territorial		Totals:
Size Group (cm.)	20—29	20—29	30—39	30—39	20—29	30—39	all sizes
Sex	♂	♀	♂	♀	♂	♀	and sexes
Number of stomachs examined	13	12	10	11	10	7	63
Number of empty stomachs	—	—	—	1	1	1	3
Number with recognizable food	13	12	10	10	9	6	60
Polychaeta	13	12	10	10	9	5	59
Terebellidae	11	10	7	8	6	4	46
Sabellidae	9	7	7	4	3	1	31
Serpulidae	—	—	—	2	5	—	7
Maldanidae	—	—	—	—	2	—	2
Oweniidae	2	5	3	1	2	—	13
Amphictenidae	—	1	2	—	3	1	7
Ampharetidae	—	—	1	1	—	—	2
Opheliidae	1	—	3	—	—	—	4
Aphroditidae	6	3	6	4	1	2	22
Phyllodocidae	5	7	4	3	3	1	23
Hesionidae	—	—	—	—	2	1	3
Nereidae	1	—	—	—	1	—	2
Nephthydidae	—	—	2	1	—	—	3
Glyceridae	—	—	—	1	—	—	1
Eunicidae	—	—	—	—	—	2	2
Crustacea	5	3	5	4	1	1	19
Decapoda	—	2	3	2	1	1	9
Amphipoda	4	1	3	3	—	—	11
Mysidaceae	1	—	—	—	—	—	1
Cirripedia	1	1	—	—	—	—	2
Mollusca	1	2	4	2	2	4	15
Gastropoda	—	1	1	—	1	1	4
Lamellibranchiata	—	1	2	1	—	—	4
Nudibranchiata	1	—	1	1	—	—	3
Chitones	—	—	—	—	1	2	3
Coelentera	2	1	1	3	1	2	10
Anthozoa	—	—	—	—	1	2	3
Hydroidea	2	1	1	3	—	—	7
Ophiuroidea	1	—	—	2	—	—	3
Gephyrea	—	—	—	—	1	1	2
Polyzoa	—	—	1	—	—	—	1
Red Algae	—	—	1	—	—	—	1

3. Vestmann Isles.

From the vicinity of the Vestmann Isles samples of lemon soles were obtained by research vessels on four different occasions — in June 1925, when 205 fish were caught by the "Explorer" in two hauls of one hour each, and also in July 1927, June 1932, and July 1939, when small quantities were taken by the "Dana". These records give no indication of the extent of the stocks in this locality but from the landings of commercial trawlers it is clear that prolific lemon sole grounds exist in the neighbourhood, particulary to the north-west, towards Selvognes. Examination of the scales gave the following age analysis (Table 10).

Table 10.

Age	1925 Brood	1925 Number	1925 %	1927 Brood	1927 Number	1927 %	1932 Brood	1932 Number	1932 %	1939 Brood	1939 Number	1939 %
2+	1923	1	0·5	1925	0	—	1930	0	—	1937	0	—
3+	1922	0	—	1924	0	—	1929	0	—	1936	0	—
4+	1921	0	—	1923	1	4·6	1928	0	—	1935	0	—
5+	1920	19	9·3	1922	0	—	1927	6	27·3	1934	5	27·8
6+	1919	34	16·6	1921	0	—	1926	2	9·1	1933	7	38·9
7+	1918	12	5·8	1920	10	45·5	1925	8	36·4	1932	3	16·7
8+	1917	34	16·6	1919	3	13·6	1924	1	4·5	1931	1	5·5
9+	1916	23	11·2	1918	2	9·1	1923	5	22·7	1930	2	11·1
10+	1915	33	16·1	1917	3	13·6	1922	—	—	—	—	—
11+	1914	27	13·2	1916	3	13·6	1921	—	—	—	—	—
12+	1913	8	3·9	1915	—	—	1920	—	—	—	—	—
13+	1912	6	2·9	1914	—	—	1919	—	—	—	—	—
14+	1911	7	3·4	1913	—	—	1918	—	—	—	—	—
15+	1910	0	—	1912	—	—	1917	—	—	—	—	—
16+	1909	1	0·5	1911	—	—	1916	—	—	—	—	—
	Totals	205	100·0		22	100·0		22	100·0		18	100·0

In 1925 the most prominent broods were those of 1919, 1917, and 1915, while once more the broods of 1921 and 1922 were unrepresented. Two years later the 1920 brood was predominant but subsequent sampling has given no clear indication of the composition of the stocks in this locality. It is interesting to record that the one and only lemon sole younger than 5+ years caught by the "Explorer" during its Icelandic cruise of 1925 was taken on these grounds. This was a 2+ fish of the 1923 class.

The average sizes, which follow, illustrate the growth in this region (Figure 2).

Age	2+	3+	4+	5+	6+	7+	8+	9+
Number	1	—	1	30	43	33	39	32
Range (cm.)	13	—	21	18—30	21—34	25—37	28—41	30—44
Mean (cm.)	13·0	—	21·0	24·0	27·8	32·4	34·3	35·8

Age	10+	11+	12+	13+	14+	15+	16+
Number	36	30	8	6	7	—	1
Range (cm.)	30—41	29—42	33—42	32—43	33—45	—	42
Mean (cm.)	35·6	37·1	37·3	36·7	39·0	—	42·0

In addition to the records from research ships, a number of measurements and scale samples of lemon soles were received from Aberdeen trawlers fishing on grounds between the Vestmann Isles and Reykjanes. These latter records are doubly interesting in that, besides confirming certain contemporary results of the research vessels in Faxa Bay, they also indicate the size and age composition of the different trade categories of small, medium, and large fish.

In the spring and summer of 1937, two boxes of "smalls" were measured. The first, designated "selected smalls", contained 173 fish ranging in size from 27 to 36 cm. with a mean size of 31·8 cm., and the second, 222 fish with a range of 24 to 35 cm. and a mean of 28·7 cm.

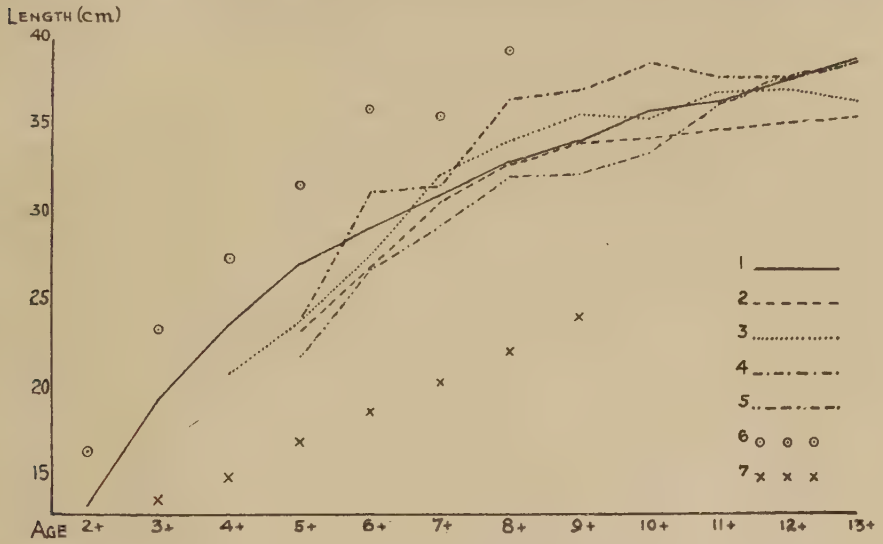

Figure 2. Lemon Sole growth at Iceland. Average sizes of the various age-groups July 1925—1939.
1. Faxa Bay (Territorial). *2.* Reykjanes. *3.* Vestmann Isles. *4.* Portland. *5.* Ingolfshöfdi. *6.* N. Myggenaes (May—June). 7. N. Rona (May—June).

Out of these boxes 64 fish were scaled. Scale readings gave the following age analysis which reveals the predominance of the 1930 and 1928 broods:—

Brood	1932	1931	1930	1929	1928	1927	1926	
Number	2	2	26	11	13	9	1	= 64
% of Total	3·1	3·1	40·6	17·2	20·3	14·1	1·6	

In the same year four boxes of "mediums" were similarly treated giving the following details:—

Number of Fish	Range (cm.)	Mean Size (cm.)
132	31—40	34·8
132	31—40	35·1
133	32—40	35·2
163	27—36	32·9

The age determination of the 115 fish which were scaled resulted as follows: —

Brood	1930	1929	1928	1927	1926	1925	1924	
Number	41	17	38	11	6	—	2	= 115
% of Total	35·7	14·8	33·0	9·6	5·2	—	1·7	

As may be expected, the 1930 and 1928 broods predominate even to a greater extent than in the "smalls".

Lastly, one sample of "large" fish was dealt with in the same way. This numbered 90 fish ranging from 36 to 45 cm., with a mean size of 39·1 cm. Twenty-six fish were scaled, giving the following age composition: —

Brood	1930	1929	1928	1927	1926	1925	
Number	3	2	6	10	4	1	= 26
% of Total	11·5	7·7	23·1	38·5	15·4	3·8	

In this case the 1927 and 1928 broods are most numerous.

In the spring of the following year two samples of "smalls" were measured. The fish ranged from 25 to 34 cm. and from 25 to 35 cm., with averages of 29·4 cm. and 29·8 cm. respectively. Fifty-five specimens were scaled, giving the following age analysis:—

Brood	1933	1932	1931	1930	1929	1928	1927	1926	
Number	3	12	3	20	4	7	4	2	= 55
% of Total	5·5	21·8	5·4	36·4	7·3	12·7	7·3	3·6	

Once again the 1930 brood is shown to be the principal source of this category and while the 1928 brood has fallen off in numbers, that of 1932 is fairly well represented.

Finally, a single box of "smalls" was obtained in April 1939. Out of 180 fish measuring from 25 to 34 cm. in length, with a mean size of 29·5 cm., twenty-five were scaled with the following results:—

Brood	1934	1933	1932	1931	1930	1929	1928	
Number	2	9	4	2	3	—	5	= 25
% of Total	8·0	36·0	16·0	8·0	12·0	—	20·0	

These commercial samples show that no lemon sole younger than 5 years of age and few younger than 6 or 7 years were included in the "small" selection, while the "medium" and "large" categories contained no fish younger than 7 years of age.

4. Portland.

The lemon sole stocks of this region have been sampled on two occasions in July 1925 and 1927. Although data are scarce, the population appears to be less dense than in regions previously mentioned. Scale readings gave the following analysis indicating the importance of the 1919 and 1920 broods.

1925										
Age	5+	6+	7+	8+	9+	10+	11+	12+	13+	
Brood	1920	1919	1918	1917	1916	1915	1914	1913	1912	
Number	1	13	4	3	4	6	9	1	1	= 42
% of Total	2·4	31·0	9·5	7·1	9·5	14·3	21·4	2·4	2·4	

1927										
Age	5+	6+	7+	8+	9+	10+	11+	12+	13+	
Brood	—	—	1920	1919	1918	1917	—	—	—	
Number	—	—	18	3	1	2	—	—	—	= 24
% of Total	—	—	75·0	12·5	4·2	8·3	—	—	—	

The average sizes for the different age-groups are presented in the following table and the resultant curve is incorporated in Figure 2:—

Age	5+	6+	7+	8+	9+	10+	11+	12+	13+
Number	1	13	22	6	5	8	9	1	1
Range (cm.)	24	27—34	28—36	34—39	35—38	36—43	33—44	38	39
Mean (cm.)	24·0	31·4	31·8	36·7	37·2	38·8	38·0	38·0	39·0

5. Ingolfshöfdi.

Samples of scales were obtained from this neighbourhood in July 1925, 1936, and 1939. From the point of view of density the population probably resembles the last region. In 1925 the 1919 brood outnumbered the other year-classes as was also the case at Portland. In the second sample the 1928 brood was outstanding as shown in the following table:—

1925												
Age	3+	4+	5+	6+	7+	8+	9+	10+	11+	12+	13+	
Brood	1922	1921	1920	1919	1918	1917	1916	1915	1914	1913	1912	
Number	—	—	3	17	—	4	10	9	5	2	1	= 51
% of Total	—	—	5·9	33·3	—	7·8	19·6	17·7	9·8	3·9	2·0	

1936												
Brood	1933	1932	1931	1930	1929	1928	1927	1926	1925	1924	1923	
Number	1	—	—	8	7	22	3	—	—	1	—	= 42
% of Total	2·4	—	—	19·0	16·7	52·4	7·1	—	—	2·4	—	

1939								
Brood	1936	1935	1934	1933	1932	1931	1930	
Number	1	—	—	3	—	—	1	= 5

Growth in this region is illustrated by the following average sizes (*vide* Figure 2):—

Age	3+	4+	5+	6+	7+	8+
Number	2	—	3	28	8	26
Range (cm.)	13—14	—	19—24	21—35	22—37	24—38
Mean (cm.)	13·5	—	22·0	27·0	29·5	32·3

Age	9+	10+	11+	12+	13+
Number	14	9	6	3	1
Range (cm.)	26—39	28—38	30—44	35—43	31
Mean (cm.)	32·4	33·6	36·5	38·0	31·0

6. North-West, North, and East Coasts.

In 1925 trawling was carried out at a number of stations along these coasts. In the north-west, in the vicinity of Isafjord, three hauls yielded 11 fish of the following age-groups and sizes:—

Age	5+	6+	7+	8+	9+	10+	11+	12+
Number	3	2	—	1	2	—	1	2
Range (cm.)	21—25	26—27	—	34	37	—	32	38—41

Further east, off the north coast proper, early investigations at Iceland record the capture of a few specimens in Steingrimsfjord, Eyjafjord, Skjalfandi Bay, and Thistilsfjord (3 a and 4). In 1925 most of the "Explorer" hauls in this region were blank, but single lemon soles were taken in the inner reaches of Hunafloi and in Skjalfandi Bay. In the latter locality six fish (30—45 cm.) were also captured by the "George Bligh" in 1936.

On the east coast not a single lemon sole was caught in a series of trawl hauls in 1925. The only records from this region are one small specimen of 17 cm. taken in Seydisfjord by means of the eel hand-seine and one of 35 cm. in the trawl in 1936 at a position 65°40′N., 14°05′W.

Conclusions.

Age Composition of Stocks. For comparative purposes the data examined for all the regions outside Faxa Bay are scarcely adequate. Only in 1925 are the records sufficiently numerous to provide a reasonably accurate assessment of the lemon sole stocks on Icelandic Grounds. The results of that year, however, indicate three features of the stocks which are reflected in the limited data collected in succeeding years.

1. The different broods composing the stocks are generally of the same relative strength in all regions. Thus the 1921 and 1922 broods, which are classed as complete failures in Faxa Bay from the point of view of recruitment of the stocks, may be regarded as such in all areas. Similarly the prolific broods in Faxa Bay are also outstanding at the different points along the south coast.

2. The Faxa Bay area contains a higher proportion of younger fish than any of the other areas. This may, however, be partly due to the imperfect sampling of the grounds to the south of Iceland and further investigation is therefore desirable.

3. Prolific broods begin to predominate in the catches earlier in Faxa Bay than in the other areas. For example, in Faxa Bay in 1925, the 1919 and 1920 broods are by far the strongest numerically. At the same time the 1919, 1917, and 1915 broods are most prominent in the catches from Reykjanes to Ingolfshöfdi and it is not until 1926 or 1927 that the excellent 1920 brood appears to advantage. Similarly in the catches of the year 1932 the very good brood of 1928, although greater in numbers than any other brood within Faxa Bay, is not even represented in the sample from the Vestmann Isles. At Ingolfshöfdi, in 1936, on the other hand, the 1928 brood supplies more than half of the total

sample, while the numbers of the 1930 brood do not suggest the strength of this brood, already evident in Faxa Bay. Finally, the 1930 brood predominates in certain commercial catches from the neighbourhood of the Vestmann Isles and Selvognes in 1937.

This lag in the appearance of broods in the catches from the south coast is no doubt partly due to differences in the rate of growth, to be discussed in the next paragraph. It is also suggested, however, that some movement of older lemon soles may take place from Faxa Bay towards the south coast. Extensive marking experiments, in addition to more regular and widespread investigations, are therefore desirable to throw light on this question.

Growth. As already pointed out the average sizes worked out to represent growth in Faxa Bay are derived from measurements and age determinations on lemon soles captured mainly in the month of July. Fortunately, operations in other areas were also carried out in the last few days of June or in July. In this way the average sizes and the resultant growth-curves are suitable for comparison (*vide* Figure 2). The irregular nature of the sampling from year to year along the south coast is unfortunate, however, with the result that in only a few age-groups are the numbers of fish sufficiently large to give accurate averages. In spite of these difficulties the evidence is clear that in the early years of the lemon sole's life, up to about 7 years of age, growth in Faxa Bay is more rapid than on other Icelandic grounds. At the age of 5+ years, for example, the average size of lemon soles from Faxa Bay is about 4 cm. greater than the corresponding size for the south coast. After the seventh year the curve for Portland and to a slight degree also that of the Vestmann Isles surpasses the Faxa Bay curve. The curves representing Reykjanes and Ingolfshöfdi, on the other hand, continue inferior to Faxa Bay. The Reykjanes curve, in particular, is markedly depressed in the later age-groups.

It must be remembered, however, that the section of the curve representing the advanced years of the lemon sole's life is more liable to alteration as a result of either a heavy intensity of fishing, when the larger fish are quickly killed off, or, paradoxically, the absence of fishing, when dense concentrations of old fish cause a shortage of food with an accompanying reduction in growth. Lack of knowledge of the intensity of fishing in the various regions recognized in the present work render impossible an accurate interpretation of the growth curves.

For comparison, curves are included in Figure 2 illustrating the best (Myggenaes — Faroe) and the poorest (North Rona — Scotland) types of growth in lemon soles so far encountered.

Spawning. According to Saemundsson, spawning occurs all round Iceland, except off the north-east coast, but is heaviest on the south coast where the water is warmest. Some confirmation of this is obtained from the present material, which, however, provides little fresh information on this subject. A few fish examined on the Scottish research ship at the end of June 1925 reveal the presence of male and

female lemon soles with ripe gonads in the southern half of Faxa Bay, even within territorial waters. None of the few 5+ or 6+ fish examined in this region was beyond the early stages of the maturing process.

During the same cruise the sex organs of 317 lemon soles were investigated from grounds stretching between Reykjanes and Ingolfshöfdi. No distinction as regards the condition of the gonads was found in the samples from the different localities. The fish were from 5+ to 15+ years old and 87 per cent. of the males and 83 per cent. of the females were in the ripe or newly spent condition. The remainder, except for a few immature 5+ and 6+ fish, were at various stages between immature and ripe. Most of the 5+ and 6+ fish were either ripe or spent.

Migratory and Feeding Movements. The different movements carried out during the lives of fishes are not well known in the case of the lemon sole. Owing to the scarcity of records of the youngest bottom forms (younger than 2 years of age) there is little knowledge of this period in the life history. Such records as do exist were gathered from a wide area, which roughly coincides with that frequented by the adult fishes (2 a). It has been noted, however, that lemon soles of about 3 years of age are particularly numerous in certain localities but they are by no means confined to such places.

Although certain areas seem to be favoured for spawning purposes, there is no evidence of a general movement towards these areas and lemon soles may spawn wherever the species is found. Neither is there any evidence of movements for feeding. The food of lemon soles in Scottish and Faroese waters (2 d and e) and also, as noted in the section on Faxa Bay, in Icelandic waters, consists largely of sedentary forms, which are unlikely to attract the more active predatory fishes in the same way as do seasonal types such as sand-eels and capelan. Further observations on the spawning, the food and feeding habits of the lemon sole in Icelandic waters are, however, necessary before any definite conclusion can be expressed on these matters.

A few marking experiments on lemon soles in Icelandic waters have already been discussed in a previous paper, but no conclusions can be derived from the results (2 b). It seems certain, however, that some migration by adult fishes does take place at Iceland just as in Faroese and Scottish waters (1). From our knowledge of the phenomenon in these regions the migratory movement probably follows a contranatant course. Thus lemon soles would move from Faxa Bay southwards and then eastwards against the currents which have been shown to exist there.

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La Variabilité et la Signification Raciale de la Moyenne Vertébrale des Clupéidés Étudiées chez la Sardine Ibérique.

Par

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DANS la copieuse information recueillie ces dernières années par l'Institut Espagnol d'Océanographie sur la biologie et la biométrie de la sardine — et que nous avons déjà publiée partiellement[1]) — celle du Laboratoire de Malaga se distingue par sa continuité et sa densité. C'est de cette dernière que nous allons extraire celle qui se réfère à la formule vertébrale et à ses variations au cours des années.

Dans le Tableau 1 sont recueillies les données relatives à 83 lots, tous de 100 exemplaires, excepté le premier de la série, réduit à 97. Nous omettons la provenance concrète du matériel puisqu'elle est en majeure partie Malaga même et ses alentours, c'est à dire un tronçon de côte (entre le Rincón de la Victoria et Torremolinos) non supérieur à 13 milles; de plus, comme on pouvait le prévoir, même en tenant compte des échantillons provenant de points plus éloignés de Malaga (de Torre del Mar jusqu'à Estepona, distants d'environ 60 milles), il est impossible de discerner des variations géographiques dans la moyenne vertébrale.

La taille des exemplaires, nageoire caudale comprise, a été mesurée au millimètre; au Tableau figurent les chiffres extrêmes et moyens de chaque lot.

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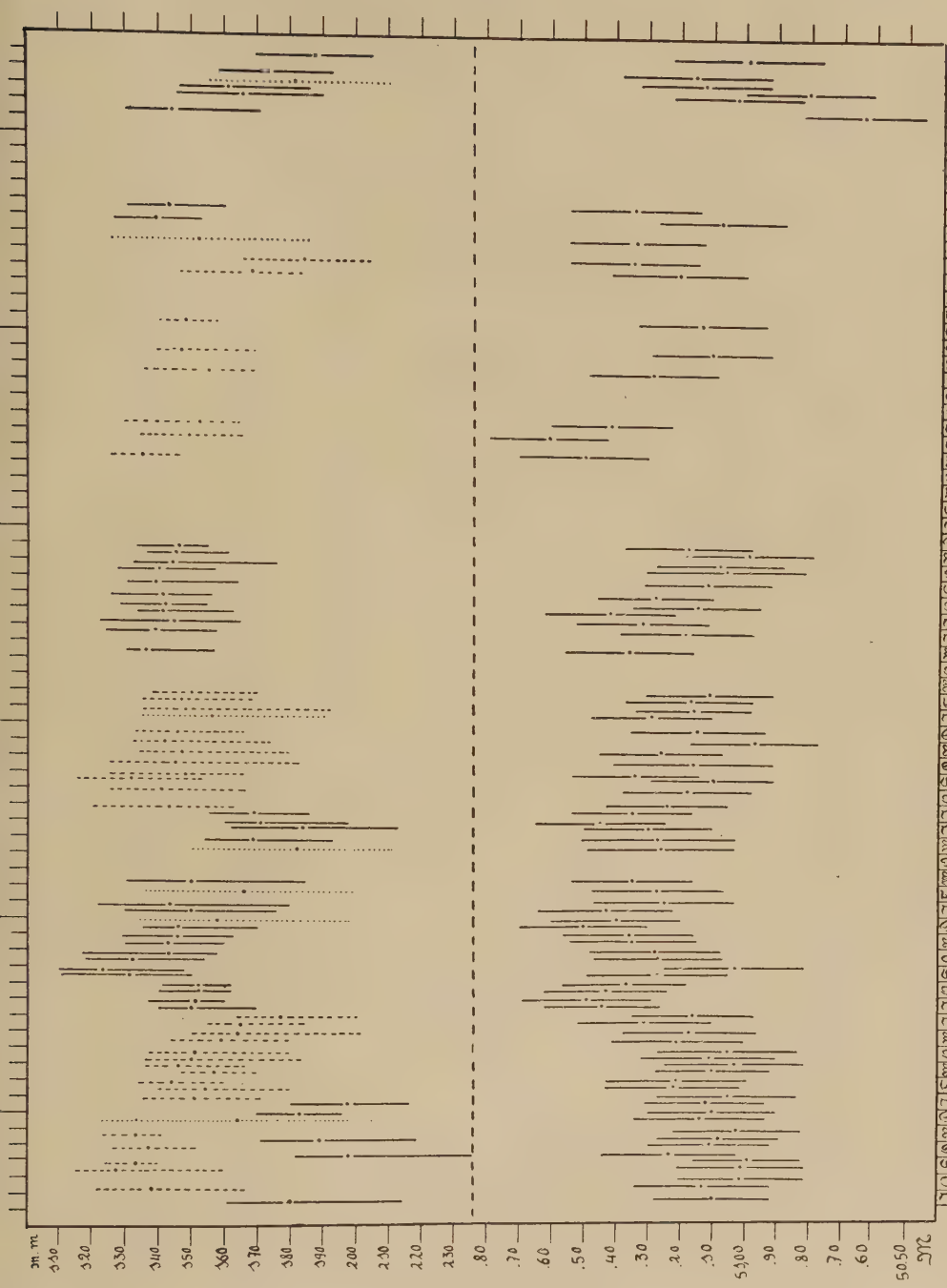


Graphique correspondant aux Tableaux 1 et 2.
En haut les tailles moyennes et extrêmes.
En bas les valeurs de M et Fl.M.

Tableau 1. Sardine de Malaga. Données de 83 Lots.

No du lot	Date et Engin[1])		Tailles Moyennes et Extrêmes (en mm.)	M	Vertèbres σ±	Fl.M±
	1940					
1	8/7	J	151—170—205	51·20	0·53	0·18[2])
2	5/8	S	111—128—157	51·23	0·63	0·21
3	16/9	J	105—117—150	51·11	0·58	0·20
4	24/9	S	114—123—130	51·09	0·49	0·17
5	7/10	T	172—188—226	51·33	0·62	0·21
6	22/10	S	116—127—142	51·21	0·55	0·19
7	4/11	T	161—180—209	51·18	0·57	0·19
8	19/11	S	113—123—131	51·12	0·60	0·20
9	14/12	J	111—154—196	51·24	0·63	0·21
10	27/12	S	160—173—186	51·20	0·58	0·20
	1941					
11	13/1	S	170—188—207	51·22	0·57	0·19
12	29/1	S	125—141—161	51·15	0·64	0·22
13	11/2	S	130—144—170	51·32	0·63	0·21
14	27/2	S	124—134—150	51·31	0·66	0·22
15	12/3	S	137—147—160	51·20	0·51	0·12
16	23/3	S	126—136—156	51·13	0·64	0·22
17	3/4	S	126—140—174	51·21	0·62	0·21
18	16/4	S	127—141—170	51·15	0·64	0·22
19	5/5	S	134—149—166	51·31	0·63	0·21
20	20/5	S	140—154—192	51·27	0·61	0·21
21	14/6	S	145—156—175	51·41	0·63	0·21
22	28/6	S	154—167—191	51·26	0·58	0·19
23	14/7	S	130—140—160	51·54	0·54	0·18
24	28/7	S	127—141—150	51·59	0·60	0·20
25	12/8	S	130—142—152	51·53	0·56	0·19
26	27/8	S	131—142—152	51·47	0·57	0·19
27	15/9	S	100—121—140	51·37	0·66	0·22
28	29/9	S	100—113—138	51·13	0·66	0·22
29	13/10	S	108—122—144	51·37	0·59	0·20
30	27/10	S	107—133—148	51·38	0·58	0·20
31	10/11	S	120—133—151	51·45	0·61	0·20
32	25/11	S	119—136—152	51·46	0·62	0·21
33	12/12	S	125—136—160	51·60	0·58	0·20
34	29/12	S	123—148—188	51·50	0·59	0·20
	1942					
35	12/1	S	120—140—166	51·53	0·62	0·21
36	28/1	S	112—134—170	51·35	0·64	0·22
37	19/2	S	126—156—189	51·37	0·66	0·21
38	1/3	S	120—140—175	51·45	0·57	0·19
39	4/5	T	140—172—201	51·36	0·67	0·23
40	25/5	T	144—159—183	51·37	0·72	0·24
41	15/6	T	152—174—203	51·40	0·58	0·20
42	30/6	S	150—161—187	51·55	0·59	0·20
43	8/7	S	145—159—176	51·45	0·57	0·19

No. du lot	Date et Engin[1])	Tailles Moyennes et Extrêmes (en mm.)	M	Vertèbres σ±	Fl.M±
44	30/7 S	110—133—153	51·34	0·57	0·19
45	24/8 S	115—131—157	51·28	0·58	0·20
46	15/9 S	105—122—143	51·20	0·56	0·19
47	28/9 S	115—138—156	51·44	0·60	0·20
48	15/10 S	115—135—173	51·26	0·74	0·25
49	6/11 S	124—137—170	51·36	0·57	0·19
50	26/11 S	122—132—164	51·07	0·59	0·20
51	15/12 S	123—136—156	51·25	0·62	0·21
	1943				
52	14/1 S	125—146—180	51·39	0·55	0·19
53	27/1 S	125—138—182	51·26	0·52	0·18
54	11/2 S	125—137—158	51·27	0·60	0·20
55	24/2 S	128—140—160	51·21	0·59	0·20
56	15/5 S	120—126—147	51·46	0·59	0·20
57	18/6 S	114—129—148	51·28	0·62	0·21
58	5/7 S	112—135—154	51·42	0·62	0·21
59	22/7 S	123—131—153	51·52	0·61	0·20
60	6/8 S	118—132—145	51·25	0·59	0·20
61	27/8 S	115—131—146	51·38	0·52	0·18
62	20/9 S	120—129—154	51·22	0·59	0·20
63	11/10 S	117—130—147	51·46	0·74	0·25
64	25/10 S	122—134—166	51·18	0·61	0·20
65	11/11 S	126—135—151	51·09	0·58	0·20
66	29/11 S	123—136—145	51·28	0·58	0·20
	1944				
67	10/5 S	115—125—136	51·60	0·60	0·20
68	21/6 S	124—139—155	51·71	0·53	0·18
69	13/7 S	119—142—154	51·52	0·57	0·19
70	16/10 S	125—144—160	51·39	0·60	0·20
71	27/11 S	129—137—160	51·21	0·57	0·19
	1945				
72	16/1 S	130—138—148	51·24	0·58	0·20
73	20/4 S	136—158—170	51·31	0·63	0·21
74	14/5 S	155—174—194	51·45	0·58	0·20
75	21/6 S	115—142—175	51·44	0·64	0·21
76	23/7 S	116—129—143	51·18	0·61	0·20
77	21/8 S	120—133—150	51·45	0·61	0·20
	1946				
78	13/2 S	120—134—161	50·74	0·56	0·19
79	8/3 J	135—155—180	51·13	0·59	0·20
80	27/3 T	136—151—176	50·91	0·60	0·20
81	3/4 J	145—171—200	51·23	0·60	0·20
82	29/4 T	148—163—183	51·26	0·69	0·23
83	23/5 T	159—177—195	51·10	0·68	0·23
	Total	n=8297	51·31	0·62	0·02

1) S = Sardinal; J = jábega; T = traíña.
2) n = 97. Pour les autres lots, n = 100.

Ces chiffres étant tributaires du procédé de pêche employé, nous devons préciser que les "sardinales", filets dérivants, sont sélectifs et leurs dimensions de maille devant correspondre à la taille du poisson sont de 10—12 noeudes par 20 cm. en hiver et au printemps, et de 14—15 mailles par 20 cm. en été et en automne. Les "jábegas" (issaugues) sont des filets traînants dont les bouts sont rattachés à la terre et le cul du sac est généralement de 13—14 mailles par 20 cm. en été et de 30—35 en hiver. Les "traiñas" sont des filets tournants à coulisse, de 800 à 1000 mètres de longueur; le nombre de fils variant de 14 à 24 par 20 cm. selon la taille possible de la sardine, le filet est fréquemment monté de morceaux à mailles de dimensions variées.

Dans ces conditions il est de toute évidence que les sardines pêchées avec sardinal sont de taille et d'âge probablement très homogènes. Par contre ce n'est pas le cas des lots provenant de jábegas et traiñas, et ainsi les valeurs moyennes obtenues, aussi bien anatomiques (taille, vertèbres, etc.) que physiologiques (poids, âge, état sexuel, etc.) sont très souvent illusoires.

Les vertèbres ont été comptées selon la norme habituelle chez les clupéidés[2]) et pour les calculs statistiques nous avons appliqué ces formules:

$$\text{Indice de variabilité, } \sigma = \pm \sqrt{\frac{\Sigma pa}{n} - \left(\frac{\Sigma pa}{n}\right)^2}$$

$$\text{Fluctuation certaine de la moyenne, Fl. M} = \pm \frac{\sigma}{\sqrt{n}}\ 3{\cdot}3725$$

Les chiffres du Tableau 1 ont été reportés en partie à la figure ci-jointe, et leur attribuant une grande valeur et utilité par leur propre poids statistique et par le fait qu'ils embrassent une période de six années consécutives, nous pouvons nous demander:—

1. La formule vertébrale est-elle fixe? Ou présente-elle au contraire des variations chronologiques bien définies?
2. Quelle valeur peut avoir la formule vertébrale dans la délimitation des races?

I. Variabilité temporelle de la formule vertébrale.

Si les données disponibles n'atteignaient pas une période aussi longue que six années, on pourrait seulement en déduire que les fluctuations de la valeur partielle de M sont purement dues au hasard dans la stricte marge de la probabilité mathématique et qu'elles correspondent à une population de sardines parfaitement homogène quant au caractère étudié. Mais dans notre longue série de dates, espacées par des intervalles de temps plus ou moins longs, il y a des valeurs de M hautes et basses

[2]) À Mme. Bellón, chargée des observations directes sur le matériel au Laboratoire Océanographique de Malaga et à ma femme, qui m'a grandement aidé dans les calculs statistiques et revision des donnés, j'exprime ma cordiale reconnaissance pour leur efficace collaboration.

bien séparées, non superposables avec l'addition des valeurs respectives de Fl.M.

Ainsi successivement nous avons:— 51·09 ± 0·17 en septembre de 1940; 51·59 ± 0·20 en juillet de 1941 et 51·60 ± 0·20 en décembre de la même année; 51·20 ± 0·19 en septembre de 1942; 51·07 ± 0·17 en décembre suivant; 51·52 ± 0·20 en juillet de 1943 et 51·09 ± 0·20 quatre mois plus tard; 51·71 ± 0·18 (la valeur la plus élevée de la série) en juin de 1944 et 51·21 ± 0·19 en novembre de la même année. La valeur minima absolue, 50·74 ± 0·19, se présente en février de 1946 et reste détachée de celle du mois d'avril suivant (51·26 ± 0·23).

Ces chiffres et le simple examen du graphique suffiraient pour demontrer que dans les bandes de sardines pêchées sur la côte de Malaga la formule vertébrale varie avec le temps et que l'amplitude des oscillations de M, bien qu'en total elle atteigne à peine un entier, excède de beaucoup celle consentie par la probabilité statistique.

Malgré cela, pour la présentation concrète et plus correcte du problème il est nécessaire de tenir compte de l'âge des exemplaires, de les réunir en classes ou générations et d'éliminer les lots où le mélange est évident; mélange qui se révèle, sans plus, par la grande variété des tailles ou par leur distribution très irrégulière en relation avec la moyenne arithmétique. Pour ce motif nous éliminons pour les calculs les lots numéros 9, 34, 37, 39, 52, 75, et 81.

Nous ne croyons pas nécessaire de recourir à l'étude des écailles que nous avons recueillies pour adjuger un âge à nos exemplaires, car — en plus que les rachis n'ont pas été préparés un à un mais par cuisson des sardines du lot en tas — nous sommes chaque fois plus convaincus que l'escalimétrie est pratiquement inapliquable aux clupéidés de notre latitude. Notre expérience à ce sujet, aussi bien pour la sardine que pour l'allache et l'anchois, est déjà grande et nous préférons déduire le type de sa croissance par des chemins plus directs.

La sardine de Malaga se reproduit en hiver, la ponte ayant lieu en décembre—mars, période qui prolongent plus ou moins les nombreux individus précoces ou tardifs. Sa croissance est rapide et à cette croissance s'ajuste la pratique de pêche en changeant la maille des filets avec la périodicité que nous avons déjà indiquée. Les alevins et les très jeunes sardines se pêchent avec jábegas près de la côte même, mêlées quelques fois avec des petits "boquerones" (anchois) et avec les "chanquetes" (*Aphya minuta*). Au large, dans la mer libre, de juin à novembre ou décembre, les sardinales de maillage 14—15 opèrent sur les sardines de 12—14 cm. nées l'hiver précédent, tandis qu'en hiver et au printemps les filets à maille plus claire (10—12 noeuds par 20 cm.) pêchent les sardines de 15—18 cm. dont l'âge est de 12 à 18 mois.

Ces renseignements nous suffisent pour, sans grave erreur, adjuger un âge à nos lots, les grouper par générations et déduire la formule vertébrale de chacune.

Dans cet ensemble de sept classes successives (Tableau 2) la valeur de M est anormale en trois, par excès dans la troisième et sixième et

par défaut dans la septième. Et il n'y a aucun doute que ces fluctuations sont substantives et non casuelles.

Il faut rappeler que la constitution du rachis a dans la sardine un caractère de grande fixité, de moindre variabilité que dans des espèces similaires et beaucoup moindre que celle d'autres pièces squelettiques — rayons des nageoires, par exemple — quand leur nombre est suffisamment élevé, autant que le nombre de vertèbres dans la sardine. Sa nature

Tableau 2. Formule vertébrale des générations successives (Sardine de Malaga).

Générations	V	*p*	Formule
1. Hiver 1938—39	50	36	$n = 497$
Lots 1, 5, 7, 10, 11	51	317	M = 51·23
	52	140	$\sigma = \pm 0{\cdot}58$
	53	4	Fl.M = ±0·09
2. Hiver 1939—40	50	145	$n = 1{,}600$
Lots 2, 3, 4, 6, 8, 12—22	51	980	M = 51·22
	52	457	$\sigma = \pm 0{\cdot}61$
	53	18	Fl.M = ±0·05
3. Hiver 1940—41	50	75	$n = 1{,}800$
Lots 23—33, 35, 36, 38, 40—43	51	894	M = 51·44
	52	788	$\sigma = \pm 0{\cdot}61$
	53	43	Fl.M = ±0·05
4. Hiver 1941—42	47[1])	1	
Lots 44—51 et 53—55	50	79	$n = 1{,}100$
	51	648	M = 51·27
	52	367	$\sigma = \pm 0{\cdot}60$
	53	5	Fl.M = ±0·06
5. Hiver 1942—43	48[1])	2	
Lots 56—66	50	70	$n = 1{,}100$
	51	644	M = 51·29
	52	368	$\sigma = \pm 0{\cdot}62$
	53	16	Fl.M = ±0·06
6. Hiver 1943—44	50	33	$n = 800$
Lots 67—74	51	408	M = 51·43
	52	342	$\sigma = \pm 0{\cdot}61$
	53	17	Fl.M = ±0·07
7. Hiver 1944—45	50	109	$n = 700$
Lots 76—80 et 82—83	51	413	M = 51·11
	52	170	$\sigma = \pm 0{\cdot}66$
	53	8	Fl.M = ±0·08

[1]) Nous n'avons jamais observé des cas évidents de fusion de vertèbres, qui doivent être extraordinairement rares dans la sardine; nous n'en avons également trouvé à Malaga aucune avec 49 vertèbres et nous croyons en la possibilité de que ces exemplaires avec 47 ou 48 n'étaient pas des sardines mais des allaches (*Sardinella aurita)*, dont la formule vertébrale dans la Méditerranée (Baléares) est de 48·15±0·07.

héréditaire paraît être très stricte individuellement et se reflète collectivement dans la petite valeur de σ ou indice de variabilité.

Ces faits exposés, nous sommes enclins à donner comme première explication des altérations de M dans les classes 1940—41, 1943—44, et 1944—45 la substitution en masse de la sardine habituelle dans les eaux de Malaga par des sardines venues d'autres régions.

Cette hypothèse s'oppose d'un côté, aux preuves et indices que nous avons que la sardine, comme d'autres poissons pélagiques abusivement appelés émigrants, accomplit tout son cycle vital dans une zone relativement petite, et pose, d'autre part, de nouveaux problèmes.

Où s'en est allée la sardine de Malaga? D'où est venue celle qui l'a remplacée? La masse immigrante a-t-elle été constituée par des oeufs, ou des larves ou alevins ou des adultes? Quels facteurs du milieu ambiant ont été la cause déterminante du déplacement migratoire? Etc. etc.

Si l'explication ci-dessus n'est pas admise, il ne reste plus qu'à supposer que la formule vertébrale, comme caractère individuel, n'a pas une grande stabilité héréditaire et peut varier sous l'impulsion de facteurs externes durant la maturation des cellules sexuelles ou au cours du développement embryonnaire; l'agent externe agit dans le même sens sur toute une génération et la variation de la formule vertébrale comme caractère collectif a une raison d'être.

Il est aussi possible, quoique moins probable, qu'il s'agisse de véritables mutations génétiques, spontanées.

Malheureusement, pour la solution d'un problème de l'envergure de celui que nous venons de poser, il serait nécessaire (a) de disposer de matériel contemporain et d'analogue qualité et quantité d'autres zones de la Méditerranée et de l'Atlantique, tant de la Péninsule que de l'Afrique du Nord; (b) de connaître en même temps les conditions du milieu ambiant et ses variations; (c) de distinguer par voie expérimentale le facteur ou les facteurs externes cause de l'émigration de la sardine ou de la mutation dans les germes sexuels et embryons.

Les difficultés d'investigation ne sont pas grandes pour le premier point; elles augmentent pour le second et elles nous paraissent insurmontables quant au troisième, étant donné l'état actuel de notre technique de laboratoire.

II. Valeur de la formule vertébrale comme indice racial.

Dans des travaux antérieurs (*loc. cit.*) nous avons réfuté les conclusions sur l'établissement de races de la sardine européenne et la distribution géographique auxquelles sont arrivés des auteurs comme Fage et F. de Buen[3]). Nous alléguons en premier lieu la faible consistance statistique de leur matériel et en second lieu — affermie par l'addition de nos données réunies depuis 1940 — l'évidence que dans

[3]) de Buen, F. — "Clupéidés et leur pêche. VII rapport." Comm. Intern. expl. scient. Médit., Rapp. et Proc.-Verb., t. 10, Paris 1937.

une même zone la valeur de M souffre avec le temps des variations de plus grande ampleur que celle consentie par la probabilité mathématique.

Cette circonstance — ignorée certainement de F a g e — a été laissée de côté par F. d e B u e n, bien que R a m a l h o l'eût signalée chez la sardine du Portugal (période 1921—27) et elle apparaît clairement dans ses propres chiffres du nord de l'Espagne.

En insistant sur notre opinion, nous résumons les chiffres obtenus simultanément dans trois localités méditerranéennes et en cinq atlantiques, en donnant la valeur moyenne de M dans l'ensemble des lots de chacune et la plus basse et la plus haute obtenues par l'addition et soustraction de Fl. M aux valeurs extrêmes partielles de M.

Iles Columbretes (1942)		51·51 ± 0·14 (n=200)	
Palma de Mallorca (1940—43)	(51·19)	51·58 ± 0·08 (n=867)	(52·02)
Malaga (1940—46)	(50·55)	51·31 ± 0·02 (n=8297)	(51·89)
Nord du Portugal (1943—44)		51·29 ± 0·13 (n=276)	
Vigo (1940—43)	(50·62)	51·28 ± 0·04 (n=2681)	(51·96)
La Coruña (1940—43)	(50·76)	51·30 ± 0·06 (n=1110)	(51·75)
Santander (1940—44)	(51·62)	52·18 ± 0·05 (n=2290)	(52·69)
Saint-Sébastien (1944)	(51·59)	51·94 ± 0·07 (n=795)	(52·47)

Notre sardine semble donc fragmentée en trois groupes, Baléares—Columbretes, Malaga—Portugal—Galice, et Santander—Pays Basque, dans lesquels la valeur moyenne totale de M est d'environ 51·57, 51·30, et 52·00. Cependant, de la plus basse valeur partielle de M (50·74, à Malaga) jusqu'à la plus haute (52·46, à Santander) il n'y a pas de solution de continuité dans la série totale des lots.

En réalité toute déduction sera fausse si on oublie la signification mathématique de Fl. M., qui n'est autre que la certitude que si dans un ensemble homogène on prend un lot de n exemplaires et obtient une certaine valeur M ± Fl. M, en étudiant de nouveaux lots du même nombre d'exemplaires, les nouvelles valeurs de M seront 999 fois sur 1000 comprises entre les valeurs M+Fl.M et M — Fl.M premièrement trouvées. C'est-à-dire, l'homogénéité est une condition imposée *a priori*. Mais comme il est certain que la population d'une zone est hétérogène, soit par migration, soit par mutation génétique, les valeurs de M et de Fl.M peuvent manquer de transcendance mathématique et par suite raciale.

Cependant, en opérant sur de grands chiffres, ces valeurs peuvent être significatives si l'action des facteurs externes déterminant la migration ou la mutation est alternativement de signe contraire en périodes ou générations successives. Pour cela, il se peut que ce ne soit pas un simple hasard que:—

(a) Nos chiffres récents coïncident avec ceux que F a g e a donnés il y a vingt ans pour la sardine des Baléares (51·63 ± 0·32; n = 56) et du sud méditerranéen (Alger et Almeria: 51·29 ± 0·14; n = 238) et avec ceux de R a m a l h o pour le Portugal (51·24 ± 0·03; n = 2837).

(b) Qu'à Malaga la valeur moyenne totale de la période 1940—43 (51·31 ± 0·03; n = 6527) ne se soit pas altérée par l'addition des lots

de 1944—46, bien qu'elle soit de générations avec une moyenne vertébrale anormale.

(c) Ni qu'en Galice on obtienne en 1933—34 des chiffres assez en accord avec ceux de 1940—43.

La notable stabilité révélée jusqu'ici, se rompt dans la mer Cantabrique. Laissant à part Gijon, d'où nous avons seulement les chiffres de 1933—34 (51·54; $n = 297$), nous commentons les valeurs très diverses obtenues à Santander: 51·69 ± 0·19 ($n = 134$) dans l'année 1919; 51·85 ± 0·09 ($n = 700$) en 1931, avec des moyennes partielles oscillantes entre 51·50 et 52·62; dans l'année 1933 la valeur moyenne est 51·74 ($n = 174$) et monte à 52·18, comme nous l'avons vu, dans la période 1940—44. Des chiffres élevés se maintiennent aussi à Saint-Sébastien (excepté celui obtenu en 1932, qui a été 51·45 ± 0·26), mais non à Saint-Jean-de-Luz, où la formule s'est établie il y a plusieurs années à 51·39 ± 0·12.

Dans la zone cantabrique (Asturies—Santander—Pays Basque) le problème se présente très embrouillé, mais de l'étude attentive des matériaux accumulés et d'autres nouveaux peut-être surgira un peu de clarté. Par la haute valeur de M sa population sardinière contraste avec celle de la Galice et par ses grandes et brusques variations se signale comme zone de friction de deux races ou plus, ou comme zone de mutation, car la haute valeur de σ (± 0·74) obtenue à Santander en 1940—44 peut être l'indice de ces deux circonstances.

Tout ce que nous avons dit antérieurement ne fait que renforcer notre scepticisme sur la valeur raciale qui a été assignée à la formule vertébrale de la sardine européenne. Si les variations de M au cours des années — qui à Malaga nous paraissent bien démontrées et dont il y a des indices dans d'autres zones du littoral ibérique — sont l'effet de simples déplacements migratoires, nous pouvons, une fois leurs lois connues, continuer de parler de races géographiques; mais si se sont des mutations spontanées ou provoquées par des facteurs du milieu ambiant, les valeurs de M manquent de signification raciale.

Conclusiones.

1ª. — En la sardina de Málaga, las variaciones de la media vertebral en generaciones sucesivas son sustantivas, no casuales, y hay pruebas indiciarias de que son de igual índole en otras zonas del litoral español.

2ª. — Dichas variaciones pueden ser debidas a mutaciones espontáneas o provocadas por la acción del medio ambiente, o ser consecuencia de sustituciones migratorias.

3ª. — La media vertebral será de dudoso valor como índice racial en tanto ignoremos las causas de sus fluctuaciones.

Travaux effectués en France sur le Saumon.

Par

R. Vibert.

L'OPINION publique a trop longtemps méconnu en France l'importance économique, touristique et scientifique du saumon. En 1936, le Service de la Pêche réussit cependant à créer à Biarritz, un laboratoire spécialement affecté au saumon et aux poissons migrateurs. Le manque de crédits ne permit pas d'y affecter de suite un assistant, puis la guerre vint qui rendit le laboratoire inutilisable.

Un grand projet a vu le jour dernièrement, pour doubler le Musée de la Mer à Biarritz d'un Centre de Recherches scientifiques, groupant les laboratoires des divers services ayant à s'occuper de près ou de loin de tous les problèmes de biologie maritime. Il est prévu que l'Administration des Eaux et Forêts y réinstallerait, en le modernisant, son laboratoire d'études des migrateurs en général et du saumon en particulier.

En attendant la réalisation de ces beaux projets, le Service de la Pêche a tout de même tenté, au milieu des difficultés innombrables de ces dernières années, d'entreprendre certains travaux dont nous donnons ci-après les principaux résultats, quelques-uns n'étant encore que provisoires.

Marquage.

Jusqu'à ce jour, la pêche maritime du saumon n'est pas pratiquée en France. La totalité des prises est faite en rivière ou dans les estuaires.

Nous ne pouvons donc actuellement entreprendre de marquage de saumons francs à partir de stations maritimes ou côtières. Par contre, nous pouvons entreprendre en rivière des marquages à grande échelle sur les jeunes saumons se rendant à la mer (smolts) ou sur les saumons adultes retournant à la mer après le frai (kelt).

Réacclimatation du saumon.

Le fleuve Adour, avec son affluent principal le Gave d'Oloron, constitue la meilleure rivière à saumons de France. Le Gave d'Oloron est formé par la jonction à Oloron du Gave d'Aspe et du Gave d'Ossau.

Dans ces deux rivières, le saumon avait disparu depuis plusieurs siècles, les barrages de la région d'Oloron interdisant au saumon de monter plus haut. De 1936 à 1938, Kreitmann et Larrieu équipent 5 de ces barrages de "passes à saumons". *La réacclimatation est actuellement un fait accompli.* Le Gave d'Ossau en particulier est extrêmement riche en tacons (parr).

Toutes ces "passes à saumons" sont pourvues de "clapets automatiques" fermant la passe au moment des basses eaux, époque peu propice en général à la montée du saumon, pour que tout le débit de la rivière soit utilisé par l'usine hydro-électrique.

Mensurations et scalimétrie.

En 1936, Millardet examine à Biarritz les écailles de 103 saumons du bassin de l'Adour (Adour—Gave d'Oloron—Nive). En 1942, Chimits examine 230 écailles de saumon du Gave d'Oloron. Malheureusement, ces 333 saumons n'ont pas été examinés ouverts. Aucune certitude n'a donc pu être établie sur leur sexe, de plus, presque tous ont été capturés assez loin du point limite d'action de la marée, nous ignorons donc la date de leur entrée en rivière. Les résultats suivants doivent cependant être retenus:

Influence de la durée du séjour en mer sur la taille et le poids (Millardet 1936).

Durée du séjour en mer	Nombre	Fréquence chiffre rond %	Poids moyen kg.	Taille moyenne mm.
2 ans	53	53	5·926	816
3 ans	38	36	8·443	924
4 ans	11	11	10·560	1024

Durée du séjour en eau douce comme tacon (parr).

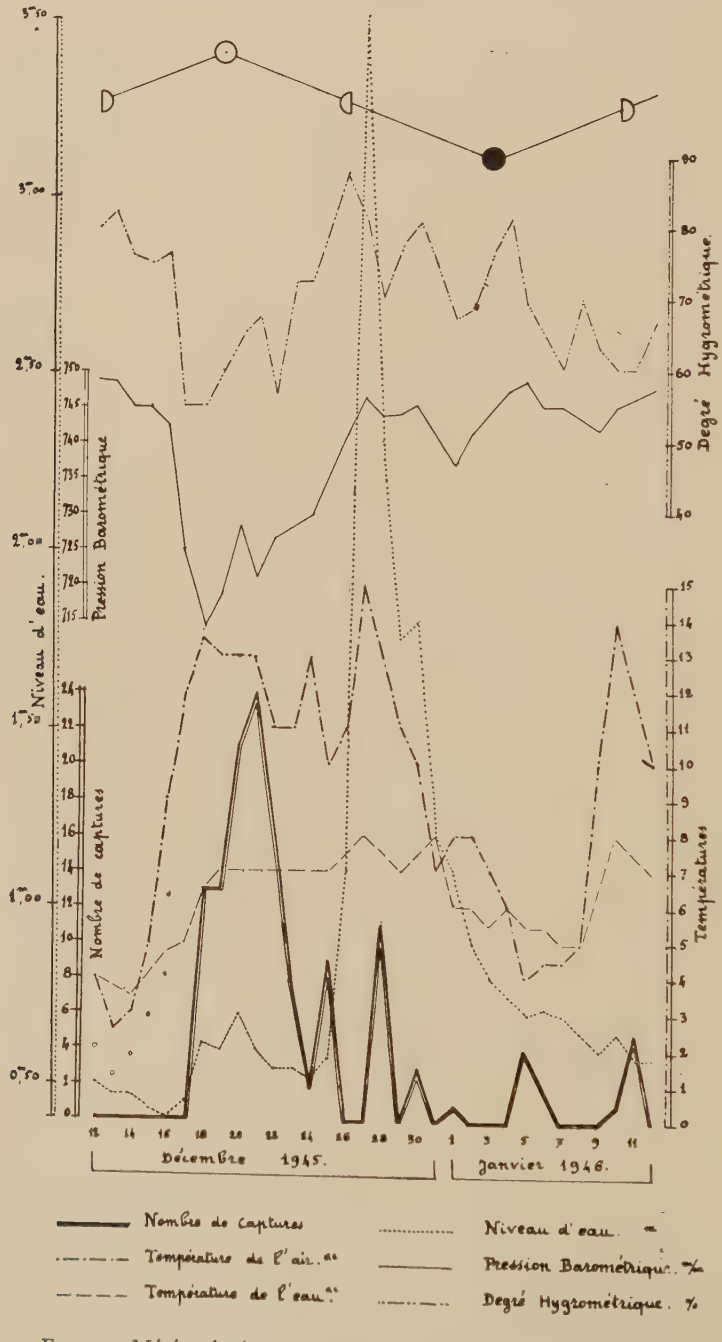
— Sur 128 saumons étudiés en 1942 (Chimits)
7 soit 5 % proviennent de smolts de 1 an
99 soit 77 % proviennent de smolts de 2 ans
22 soit 17·5 % proviennent de smolts de 3 ans.

Facteur condition.

— 1942 (Chimits) sur 126 saumons de montée: $K = 100 \frac{P}{L.3} = 1{\cdot}388$.

Rapport entre la durée du séjour en mer et la durée du séjour en eau douce – (Chimits 1942).

Le nombre de smolts de 2 ans revenant après deux ou trois ans de séjour en mer est à peu près à égalité (42 contre 50). Les smolts de 3



Facteurs Météorologiques et Passages de Saumons aux Echelles.

ans, ont au contraire une préférence pour ne rester que deux ans en mer (15) et non trois (7). Ces chiffres ne peuvent pour le moment donner que des indications, il y aura lieu de poursuivre ces travaux sur une beaucoup plus grande échelle pour en tirer des conclusions nettes.

La Maison "Volga" a monté cette année une fumerie de saumons sur le bord de l'Adour, à peu de distance de la limite de salure des eaux et nous a autorisé à faire chez elle tous les mensurations, prélèvements d'écailles, pesées de viscères et organes génitaux au moment de l'ouverture des poissons. Nous espérons donc, grâce à elle, pouvoir un jour soumettre des travaux plus complets sur ce sujet au "Comité du Saumon".

Pisciculture.

En Décembre 1942, nous avons pu mettre au point une nasse à saumons à la sortie amont d'une passe à saumon. Nous avons pu constater que le saumon remontait encore en pleine période de frai, cette seule et unique nasse nous ayant procuré en 3 années : 800,000 œufs, 400,000 et 500,000 œufs. Les femelles immatures étaient remises à l'eau et n'étaient pas gardées en stabulation.

Facteurs climatiques conditionnant les montées de saumons dans les passes à saumons.

Le fonctionnement de notre nasse à saumon s'est révélé d'une irrégularité étonnante. Pendant 8 ou 10 jours, on pouvait voir les saumons évoluer et frayer à l'aval du barrage, sans enregistrer une seule prise, puis, en 24 heures, 10, 20 et même 40 saumons se précipitaient dans la nasse. Nous avons alors enregistré les variations des différents facteurs climatiques pour étudier leur influence: pression atmosphérique, degré hygrométrique, température de l'air et de l'eau, niveau de l'eau, phases de la lune ...

Les "indications" que l'on semble pouvoir retenir jusqu'à présent de ces premières observations, *faites en période de frai,* sont les suivantes:

1.) Aucun rapport net entre les prises et les phases lunaires.
2.) Pas de rapport net entre les prises et le niveau d'eau ou ses variations.
3.) Prises nulles par fortes crues et eaux sales.
4.) Coïncidence fréquente avec élévation du degré hygrométrique.
5.) Les jours des prises sont en général *précédés* par une élévation de température de l'air, puis de l'eau.

Cette étude serait à poursuivre plus avant, en tenant compte de la luminosité et du vent. Son importance pratique pourrait ne pas être négligeable, car il serait très utile de pouvoir, grâce à une station météorologique sommaire, prévoir quelques heures à l'avance les montées de saumons, pour donner par téléphone aux usines hydro-électriques, l'ordre

d'ouvrir les passes à saumons. Celles-ci pouvant au contraire être fermées, en dehors des périodes de montée, pour ne pas diminuer le débit d'eau consacré à la production de l'électricité.

Maturation sexuelle du tacon — (parr) mâle.

Comme ceux de Scandinavie ou des Iles Britanniques, les tacons (parr) mâles de France, arrivent à maturité sexuelle en eau douce à l'âge de 2 et même 1 an. En 1928, L a r r i e u pratique avec succès la fécondation artificielle de femelles de saumons avec tacons (parr) mâles.

Pourcentage des sexes, développement sexuel.

Du 5 au 8 Avril 1946, nous avons pu faire quelques observations sur une descente de smolts. Nous avons noté leur développement sexuel suivant l'échelle ci-après, établie par O r t o n - J o n e s et K i n g en 1938, qui est très pratique et pourrait être généralisée pour de tels travaux.

— Stade 0 — Aucune glande sexuelle visible à l'oeil nu.
— Stade 1 — Présence d'une glande sexuelle tubulaire d'environ 1 mm. de large.
— Stade 2 — Glande sexuelle d'environ 5 mm. de large.
— Stade 3 — Glande sexuelle s'étendant jusqu'à la moitié de la cavité abdominale.
— Stade 4 — Glande sexuelle dépassant légèrement la moitié de la cavité abdominale.
— Stade 5 — Glande sexuelle complètement développée remplissant la totalité de l'espace libre de la cavité abdominale.
— Stade 6 — Glande sexuelle complètement développée et mure, le sperme suintant à l'extérieur. Poisson en train de frayer ou sur le point de l'être.
— Stade 7 — Glande sexuelle épuisée.

Le lot échantillon, capturé au carré, comprenait 350 smolts et 25 truites argentées de descente, proportion inattendue si l'on considère que, dans l'Adour, le nombre de truites de mer capturées est insignifiant par rapport aux saumons.

Sur ce lot, 216 smolts et 13 truites argentées furent pris, mesurés et ouverts pour vérifier la proportion des sexes qui s'établit ainsi:

Smolts femelle	— stade 2 —	140	64 %
Smolts mâle	— stade 1 —	58	27 %
Smolts mâle	— stade 7 —	18	9 %
	Total:	216	
Truite argentée femelle	— stade 2 —	12	
Truite argentée mâle	— stade 1 —	1	
Truite argentée mâle	— stade 7 —	0	
	Total:	13	

Il est intéressant de remarquer:

1.) que sur 436 saumons pris dans notre nasse d'Oloron en 3 saisons de frai, nous avons eu 285 femelles, soit 65 %, contre 64 % de femelles dans les smolts. Reste cependant à expliquer l'absence presque totale de tacons (parr) femelles dans les prises faites à la ligne ou au filet.
2.) sur le lot de smolts mâles, 25 % seulement avaient déjà frayé (stade 7).
3.) nous n'avons encore pu trouver aucun male ayant déjà frayé parmi les truites argentées de descente.

Le poids des ovaires des smolts femelles variait de 2 à 6 ‰ du poids du corps, contre 2 à 10 ‰ pour les ovaires des saumons de montée femelles examinés de Janvier à Mai 1946 à la limite de salure des eaux de l'Adour.

Le poids des testicules au stade 7 des smolts mâles variait de 3 à 8 ‰ du poids du corps contre 1 à 2 ‰ pour les testicules de saumons de montée mâles examinés de Janvier à Mai 1946 à la limite de salure des eaux de l'Adour.

Passage du stade Parr au stade smolt.

Le 11 Janvier 1946, neuf tacons (parr) mâles, en pleine période de frai (stade 6) furent placés dans un aquarium du Musée de la Mer à Biarritz et accoutumés progressivement à l'eau de mer. Trois moururent par suite d'une accélération trop rapide de la salure. Le 6 Avril, les six survivants étaient à l'eau de mer pure et avaient revêtu complètement leur livrée de descente bleu argent. Quatre sacrifiés le 10 Avril avaient leurs testicules au stade 7 typique, confirmant le bien fondé du critérium de détermination de Orton-Jones et King.

Euryhalinité.

Le 10 Avril 1946, nous avons apporté à l'aquarium du Musée de la Mer à Biarritz, 20 smolts et 6 truites argentées de descente.

Les truites argentées résistèrent mal à l'augmentation de salure, même très progressive. Une seule put atteindre sans dommage l'eau de mer pure.

Les smolts au contraire montrèrent une indifférence remarquable au degré de salure. Ils passèrent brutalement à l'eau de mer sans dommage. Après 15 jours à l'eau de mer, ils purent repasser encore brutalement à l'eau douce sans manifester la moindre gène, puis revenir à l'eau de mer.

Reviews.

Georg Wüst. "Die Dynamischen Werte für die Standardhorizonte an den Beobachtungsstationen." Unter Mitarbeit von A. Defant. ("Quantitative Untersuchungen zur Statik und Dynamik des Atlantischen Ozeans".) Wiss. Ergeb. Deut. Atlantischen Exped. a. d. Forschungs- und Vermessungsschiff "Meteor" 1925—27. Bd. **6**, 2. Teil, 3. Lieferung, S. 99—180. Berlin und Leipzig, 1938.

This voluminous compilation of serial temperatures, salinities and dynamical values in the Atlantic from 20° N. Lat. to 65° S. Lat. is based upon rigidly examined original observations carefully co-ordinated and later interpolated (Bd. **4**, 2. Teil).

The first five pages contain a detailed discussion of the method of computation accompanied by a general chart of the stations occupied, and the tabulated results corresponding to 310 well distributed stations are presented in the remaining seventy-six pages.

In making the dynamic computations, from tables of t° C., S $^0/_{00}$ σ_{st}, the usual indication of density, (Bd. **4**, 2. Teil) the simplified method of Hesselberg and Sverdrup published in 1915 was used. Thus, proceeding from σ_{st} the required indication of density *in situ*, $\sigma_{t,s,D}$ was calculated by a simple rapid process involving a few tabulated correction terms.

The pressure, p, was found by simple numerical integration of $\sigma_{t,s,D}$ with respect to the depth D. The computations were made and results tabulated with due regard to relative magnitudes of observational and computational errors, such as errors in depths of observations determined by thermometrical methods and errors due to using the same number to express the depth in all three units, geometric metres, dynamic metres and decibars.

In the table corresponding to each station is entered the date, position (tenths of minutes), and sounding. The tabular entries are as follows:

Col. 1 Standard depth, metres
Col. 2 Temperature, t° C
Col. 3 Salinity, S $^0/_{00}$
Col. 4 Indication of density *in situ*, $\sigma_{t,s,D}$
Col. 5 Pressure in decibars
Col. 6 Specific Volume σ, m.^{3}/ton
Col. 7 Anomaly of spec. Vol. 10^5 $(\alpha - \alpha_{35.0,p})$
Col. 8 Depth of isobaric surface in dynamic metres
Col. 9 Anomaly of depth of isobaric surfaces — 10^4 $(D—D_{35,0,p})$

The standard values 0, 25, 50, etc. of column 1 signify geometric metres in relation to columns 2 and 3, dynamic metres in relation to columns 4 and 5 and decibars in relation to columns 6 to 9.

Calculation of the anomalies, columns 7 and 9, was based upon Dr. Sverdrup's original manuscript tables, carried to 4 or 3 decimals, of the pressure at standard dynamic depths and depths in dynamic metres of isobaric surfaces for water of 35 $^0/_{00}$ at 0° C. However, the last two figures in columns 8 and 9 of dynamic depths and their anomalies have no physical significance.

After completion by Fräulein M. Asche of the dynamic calculations according to Dr. Defant's plan, under the supervision of Dr. Wüst and subject to further checking by Drs. G. Dietrich and G. Neumann an opportunity was offered to apply an independent check. In 1933 Dr. Sverdrup published his simplified and rapid method of calculating directly anomalies of dynamic values with the aid of only three small tables, requiring only one-way interpolation. All of the anomalies of specific volume and dynamic depths were thus calculated with the aid of Dr. Sverdrup's extended manuscript tables, in order to reveal errors of computation made in applying the earlier more complicated methods. These results confirmed the earlier conclusion that the last two figures in the anomaly of dynamic depths are of only computational significance.

Because of the painstaking care that Dr. Wüst and his colleagues have devoted to the preparation of these dynamic values, results notably free from errors are assured. They have made a remarkable contribution to basic data so essential for investigating the hydrodynamics of the South Atlantic Ocean.

Geo F. McEwen.

F. Spinnangr. "Om varsling av tåke i Vest-Norge." Bergens Museums Årbok 1941, Naturv. rekke, No. 5, pp. 1—39, figs. 12. Bergen, 1941.

J. Eggvin and **F. Spinnangr.** "Fog Forecasting and Sea-Surface Temperature." Rep. Norwegian Fish. and Mar. Invest., Vol. **7**, No. 9, pp. 1—20, 12 figs. Bergen, 1944.

Fog is one of the worst handicaps that weather imposes on those whose interest and livelihood are in seagoing vessels, and it is a major responsibility of the meteorologist who prepares weather forecasts for shipping to issue warnings of fog to all those concerned.

In the earlier of these two papers the author has analysed all the meteorological charts for the occasions when fog was reported off the Norwegian coasts during the years 1935 to 1939. He found that the large majority of fogs were either frontal — that is to say the fog was caused by the evaporation of comparatively warm rain falling through colder air which in effect causes the base of the frontal cloud-sheet to become progressively lower until it touches the sea-surface — or advectional due to the cooling of damp air while travelling over sea water the temperature of which is lower than the dew point of the air. This latter type of fog is usually the more extensive and persistent. The analysis shows that the air masses in which it most often occurs are maritime tropical and returning maritime polar but although these air masses will be recognized by the forecaster and their dew points will be known or estimated with reasonable accuracy, a confident forecast cannot be made unless the actual, as opposed to the average, sea-surface temperatures are available.

In the more recent of the two papers the authors publish monthly sea-surface temperature charts, with isotherms for every $^1/_2{}^\circ$ C., that are probably more reliable than any hitherto available, and give some excellent practical advice as to what variations from the average may be expected at different times of the year as a result of the prevalence of off-shore or on-shore winds during the preceding few days. Off-shore winds, it is noted, cause an upwelling of water from below, and the temperature of this sub-surface water is usually appreciably colder than that which it replaces during late spring and summer, and warmer during the winter months.

These papers will prove a valuable contribution to the art of fog forecasting in other areas than off Norway, for upwelling also occurs in other parts of the world and is liable to be forgotten; and if the authors' appeal for more reports of sea-surface temperatures from ships in the northern part of the North Sea is successful, there should indeed be an improvement in the fog warning service.

C. R. Burgess.

H. Thompson. "Pelagic Tunicates in the Plankton of South-eastern Australian Waters, and their Place in Oceanographic Studies." Commonwealth of Australia, Council for Sci. Indust. Res., Bull. 153, Melbourne, 1942.

This paper, produced by the photo-lithographic process, is a further step in the development of the now firmly established relationship between fisheries and oceanographical conditions through the medium of plankton investigations. It deals with an area where pelagic tunicates form a much more considerable proportion of the total plankton than they do in the area in which the International Council usually operates. In south-eastern Australian waters they form 25·4 % of the average plankton catches, and are second only to the Crustacea. The number of species is comparatively large — 23 species of Copelata, with *Oikopleura longicauda* dominant, and 21 species of Thaliacea with *Thalia democratica* dominant amongst the salps, and *Doliolum denticulatum* the more abundant of the two doliolids present. This large number of species present is associated with the warm water. There is evidence to show that no sub-antarctic influence affects the area which is therefore treated as self-contained, although the Barrier Reef area to the north is confirmed as having its own distinctive and characteristic fauna. The change from north to south in the pelagic tunicates in the south-eastern area consists in the dropping out of circumtropical species as one travels south, and not of the addition of cold water species.

The author compares the rich demersal, moderate pelagic fishery off Newfoundland and the North European coasts with the rich pelagic, moderate demersal fisheries of Japan, California, and Australia. The south-eastern Australian fishery is, however, more nearly akin to the Japanese and western Pacific areas than to the Californian and eastern Pacific. Unlike most other groups in the plankton the tunicates are much more abundant in sub-tropical waters than in the great fishing areas of the colder regions, although the total plankton is of only moderate proportions. The relationship between the tunicates and the rest of the plankton, and between the plankton in general and the oceanographical conditions is discussed at length and with an abundance of references. Seasonal and vertical distribution are discussed and annual

variations covering the period May 1938 to January 1941 are included, these showing a progressive decline in the total plankton value from 1939 onwards.

Comparing the species from south-eastern Australian waters with those found in the North Sea, Thompson includes *Cyclosalpa pinnata* in the list from the North Sea. In the reviewer's experience this species does not occur in that neighbourhood, and in fact, the list given is more characteristic of the Atlantic water approaching the British Isles than that of the North Sea itself. On page 32 it is stated that these tunicates enter to some extent into the food supply of fishes. It would have been pleasing to have seen this amplified in some detail, as although we have evidence from northern waters of the inclusion of *Oikopleura* spp. as food of pelagic fishes we have very little information about salps and doliolids being similarly included.

The paper is full of excellent detail and is a valuable addition to our all too scarce literature on the subject. The classification used follows that of the Handbuch der Zoologie, but following Garstang ("Terra Nova") for doliolids. *Dolioletta gegenbauri* and *D. tritonis* are therefore correctly included as one species, but it would have been interesting to know if both varieties occur there as they do in northern waters, and if so, if there are any geographical or physical differences in their distribution. I look forward to seeing the promised publication on the systematic side.

J. H. F.

G. L. Clarke, E. L. Pierce and **D. F. Bumpus.** "The Distribution and Reproduction of *Sagitta elegans* on Georges Bank in Relation to the Hydrographical Conditions." Biol. Bull., Vol. **85**, No. 3. Cambridge, Mass., 1943. (Wood's Hole Collected Reprints, Contrib. No. 328, 1944).

Georges Bank is, roughly speaking, a flat-topped plateau covered by 40—100 metres of sea and surrounded by much deeper water, especially in the north, east, and south. The water over the bank is a relatively stationary eddy, and the present work does much towards elucidating the degree of permanence of this eddy. There is a vertical mixing of the water over most of the bank resulting in a nearly uniform distribution of temperature and salinity from top to bottom and this position is termed the *Mixed Area.* The water has been largely derived from the Gulf of Maine.

Samples were collected on 11 cruises from September 1939 to June 1944 mostly by the Clarke & Bumpus Plankton Sampler, filtering normally between 10 and 20 m.^{3} per haul, from 21—52 stations per cruise. The number of *Sagitta elegans* was counted and reduced to the number per m^3. of sea water at each station, bearing in mind the depth and differing densities of *Sagitta* in differing depth strata. Numbers varied from 0 to 165, but averaged above 10, per m^3. (A sample from a rich "*elegans*" area off the east Scottish coast in September 1946 worked out at about 12 per m^3.). In all cruises the density of the population was greatest at the centre of the bank but there is evidence to show that a small proportion were carried off westwards. The distribution is correlated with the salinity distribution and a close agreement found.

The vertical migration, life history, and the effect of temperature on growth rate and maturity are all taken into consideration in a painstaking attempt to elucidate the relationship between the *Sagitta* population and the hydrography of the area. That the water mass is sufficiently permanent to

allow *Sagitta* to accumulate and reproduce is confirmed as one of the governing factors, but the authors suggest that other ecological factors play an important part.

Calanus finmarchicus, like *S. serratodentata* and *S. enflata* are sharply excluded from the Mixed Area of Georges Bank, whereas *Pseudocalanus minutus* and *S. elegans* are chiefly abundant within it.

Just what the factors are — other than the permanence of the water mass — that makes Georges Bank (or any other "*elegans*" community!) so favourable for that species is not completely clear. Temperatures and salinities are ruled out as limiting factors as figures similar to those from the bank are within the range found in the central region of the Gulf of Maine where the species is scarce. Turbulence, homogeneity of the water, and shallowness are discounted on comparison with other local areas. There remains the vague explanation that some element exists in water, originally derived from the shore or bottom. That *S. elegans* is characteristic of the fauna of water of mixed oceanic origin, with some coastal or bottom influence, is true of both sides of the Atlantic, having been demonstrated from both English Channel and Scottish areas. In the Scottish area at least, the *Calanus* distribution tends to run parallel to that of *S. elegans* and not contrasting with it. How this "bottom or shore" influence might affect the water is at present unknown, but if it is sufficient to effect such a biological change, encouraging some species and discouraging others, its importance needs much stressing and further investigation from various angles.

J. H. F.

R. H. Fleming. "Composition of Plankton and Units for reporting Populations and Production." Proc. 6th Pacific Sci. Congress, Vol. **3**, pp. 535—540. San Francisco, 1941. (Scripps Inst. Oceanogr., Contrib. 104. La Jolla, 1942).

The ratio of carbon to nitrogen to phosphorus has been calculated from Vinogradov's data for selected plankton organisms, yielding the following mean values:—

	C	N	P
Phytoplankton	42	7	1
Zooplankton	40	7·4	1

A comparison is made between these ratios and those obtained in Redfield's analyses of plankton organisms, and the similar ratio of combined nitrogen to phosphate-phosphorus which occurs in sea water is discussed.

On the basis of the mean values found by Vinogradov, relations between these elements and dry plankton weight, volume, settling volume, and plant pigment content have been calculated.

H. W. H.

G. A. Riley. "Physiological Aspects of Spring Diatom Flowerings." Bull. Bingham Oceanogr. Collect., Vol. **8**, Art. 4, pp. 1—53, 15 figs. New Haven, Conn., 1943.

The waxing and waning of populations of the diatom *Nitzschia closterium* in culture have been investigated and compared with the growth cycle of the natural mixed diatom population in the Gulf of Maine. The sinking rates of *Nitzschia,* during the period of its most active growth when the

population was at its peak and while it was declining, were also measured, and compared with similar measurements of naturally occurring diatoms.

The growth cycle of *Nitzschia*, seeded into sea water, or enriched sea water, and illuminated with either daylight or continuous artificial light, is considered as three phases. An initial lag period, which was not always present, appeared to be little affected by the environment but to be longer in those experiments where the quantity of inoculum was small. In the logarithmic growth phase which followed, the rate of growth depended largely upon the illumination and temperature while the continuance of this period of rapid growth depended upon the available supply of inorganic constituents. Thus the peak population could be determined by either the available nitrogen or phosphorus being used up. In a most interesting experiment it was shown that where the peak population was apparently limited by lack of these nutrients,

(i) the addition of either one or the other allowed a slight increase in maximum population to develop, while the addition of both allowed a considerable increase.
(ii) a heavy dose of manganese alone or of gallium alone acted as stimulant and caused a greater maximum population to be attained, without the addition of nitrate and phosphate.

Thus some stimulation of growth may result from the addition of any one of several substances. The classic law of the minimum is not rigid. In this connexion it is pertinent that K e t c h u m has shown that *Nitzschia* will continue growth after all the phosphate in the medium has been exhausted, and give rise to cells containing no more than a fifth of their normal phosphorus content.

It would appear that the period of logarithmic growth ends and the population increases more and more slowly at the time when one or more nutrient salts or essential accessories, such as iron or manganese, become deficient. Furthermore the effect of such an inorganic deficiency can be exacerbated by less light. The reviewer's experience is that rise in pH with consequent decrease in carbon dioxide tension is also a factor in limiting the maximum population attained by centric diatoms in culture, and that the absence of other, as yet ill-defined, growth-promoting accessories often exerts a considerable influence. Thus the addition of soil extract to a medium rich in nutrients, iron, and manganese may have a potent effect on the maximum population attained.

The photosynthetic activity of *Nitzschia* cells was greatest during the logarithmic growth phase, decreasing as the population reached its maximum. The respiration of the cells was low during this period, increasing afterwards. However, the greater number of bacteria in the later stages may have occasioned or partly occasioned this apparent increase.

When subsamples of an actively growing culture were placed in the dark a considerable increase in population ensued, to be followed by a gradual decrease. This fall in population was slower than the fall in population of an illuminated culture which had passed its peak. On the other hand, when a sample was taken from a culture which had passed its peak, the decrease in population was more rapid in the dark than in the light. These observations show a marked difference in the "physiological state" of the diatoms when taken from a culture during the logarithmic phase or later.

Experiment with naturally occurring diatoms indicated a similar difference. Water kept in a dark bottle showed that an increase in diatom population occurred when the water was collected before the diatom population had reached its maximum in the sea, and a decrease when collected after the maximum had been reached and plant life was waning.

After the logarithmic phase, the rate of cell division in culture slowed, a maximum or peak population was attained, and the population then declined. No mention is made of what happened to the dead *Nitzschia* cells, whether empty frustules remained or whether these had dissolved. During this period there was a marked increase in the ratio of unhealthy-looking cells to well-formed healthy cells. The author terms the former senile cells, and the period one of senescence. This is an unhappy term, implying that the life of a *Nitzschia* cell must of necessity draw to an end, that it cannot, like an old soldier, live for almost ever. There is at least some reason for supposing that its possible span of life may be indefinitely long, provided that the environment remains in all respects suitable. Even without changing the water, a single *Skeletonema* cell has produced 1·8 million offspring in an experiment by B r a a r u d.

Some of the unhealthy or senile cells in the declining *Nitzschia* cultures remained alive although inactive, since they would again start dividing on renewing the water, that is, improving the chemical environment which had become unsuitable in the old culture. The inactive cells in a declining culture sank less rapidly than those in the logarithmic growth phase, whose sinking rate approximated to 5 cm. pr. day. However, inactive cells in a population which had reached its maximum tended to agglutinate into masses which sank rapidly. A similar tendency was noted in a natural plankton population.

The observations made in these parallel experimental studies, of *Nitzschia* in culture and the natural population over Georges Bank, indicate two likelihoods.

The start of the spring diatom increase is known to depend at least largely upon physical factors, light and limited turbulence. However, it was noticed that the diatoms in natural waters kept in light bottles at the end of March did not grow rapidly, whereas in mid-April when the natural flora was growing rapidly, there was a very rapid growth in samples of water kept in light bottles. The tentative conclusion is drawn that before the spring increase starts, the diatoms are in a less active physiological state, comparable to the lag phase in culture experiments.

The end of the spring increase and often rapid decline in diatom population is in some areas or some years coincident with a considerable increase in grazing animals and with the occurrence in the water of great numbers of faecal pellets. In other areas, as Long Island Sound and perhaps over Georges Bank, grazing can only be considered as a contributory cause of the decline. During this investigation it was observed that in early May after the peak of the diatom flowering there was almost universally present only a sparse surface crop, much of which looked rather debilitated, and a much larger population at some lower level. This ties with the observation that the proportion of inactive, unhealthy-looking *Nitzschia* cells increases at this phase of the growth cycle; these cells tend to agglutinate and sink rapidly. In the *Nitzschia* experiments this phase was induced by deficiencies in the chemical environment. However, Georges Bank plankton increased in some of the light bottle experiments at this time, showing that they were not like

the senescent *Nitzschia* cells in a declining culture. Yet it seemed from these experiments that conditions for growth were not so favourable as they had been earlier in the season, but this could only account in part for the scarcity of diatoms.

Further study of the physiology of diatoms and autotrophic flagellates presents a rich field, and there can be little doubt that such will advance our knowledge of the productivity of the sea. *H. W. H.*

H. W. Graham. "Chlorophyll-Content of Marine Plankton." Journ. Mar. Research, Vol. **5**, No. 2, pp. 153—160, 1 fig. New Haven, Conn., 1943.

The quest for a method of estimating the standing crop of phytoplankton presents two problems. It is necessary to collect a fair sample of organisms from a known volume of sea, and then to assess the quantity of phytoplankton in it. Although it is simple to measure the volume of water filtered by a net, the finest silk lets the smaller plant organisms through it. In some areas, as in the Southern Ocean and at some seasons in temperate seas, the great bulk of vegetation is caught. At other seasons, or in other areas, smaller organisms are not only very much more numerous but may outweigh the larger diatoms which a net will retain. The practical difficulty of separating all the organisms by passing samples of the water through a fine filter is the time taken to obtain a sufficient quantity. However, in the rich waters of the Kiel Fiord, K r e y has successfully used a membrane filter while R i l e y has used filter paper, finding that this retained some 95 % of the organisms in waters off the east coast of America.

G r a h a m has followed the latter method, finding that more than 95 % of the phytoplankton in the water off the Californian coast during the summer months was retained. However, there are places where at certain seasons the bulk of the plankton organisms are very minute — flagellates and small diatoms of 3 to 6 μ in diameter. These readily pass through filter paper.

In order to estimate the phytoplankton in a mixed sample, counting the organisms has disadvantages. They vary greatly in size, not only between different species but also between individuals of the same species taken at different times or at different places. They vary greatly in their contents, some containing much water, others appearing nearly full of meat. Where the information is required for study of the productivity of the sea, it is knowledge of the quantity of vegetable organic matter, of potential food, which is sought. Counts do not supply this in easily comprehensible form. Where the information is required for study of distribution of species or of overall size such counts become necessary.

In order to provide an estimate of the plants in mixed plankton with rapidity, recourse has been had to measuring their contained chlorophyll. Although the relative quantity of chlorophyll to organic matter varies, not only between species but with the illumination in their environment, it serves as an index of their organic content or food value, *faute de mieux*. The methods employed have been to extract the colouring matter with acetone or alcohol, and either compare the colour visually with reproduceable standards where freedom from much colouring matter of animal origin permits, or to extract the chlorophyll from the mixed pigments and measure its colour

against pure chlorophyll, or measure the absorption of light of wavelength which is absorbed by chlorophyll in the mixed pigment extracts.

The last technique has been employed by Krey who used a Pulfrich photometer, while Graham has successfully used a visual spectrophotometer with light within a narrower band of wavelengths.

By filtering four litres of water, which occupied 15 minutes, sufficient plankton was obtained to extract with acetone, filter the extract, and estimate the light around 668 μμ which was absorbed.

The quantity of chlorophyll estimated in this manner from water taken off La Jolla at intervals during the summers of 1941 and 1942 varied between 0·3 and 1·8 mg. per cubic metre.

Comparing these values with those found by other investigators in the Atlantic and Kiel Fiord, it would appear that the summer surface-water off La Jolla was by no means rich in phytoplankton and it suggests that the rapidity and sensitivity of the method is a distinct advance on previous techniques.

Counts of the phytoplankton organism in the samples were also made. If allowance is made for the size of the different species, a general relation between numbers of organisms present and chlorophyll per cubic metre can be seen.

H. W. H.

Poul Jespersen. "Investigations on the quantity and distribution of zooplankton in Icelandic waters." Medd. fra Komm. for Danmarks Fiskeri- og Havunders., Ser. Plankton, Bind **3**, No. 5, Copenhagen, 1940.

This paper is mainly based on material collected by the "Dana" in Icelandic waters during the years 1924—27, 1931—34, and 1938—39. For some organisms additional data from the Denmark Straits and East Greenland waters are included. The investigations cover the spring and summer months (but mainly June, July, and August), and are principally concerned with plankton collected in the upper 50 metres of water. Owing to the varying objectives of the research programme a number of gears have been used for the special plankton work, and the results are only directly comparable from year to year in that a 2-metre stramin net has been used throughout for the fishery investigations. The main emphasis in this valuable paper is given to the seasonal changes in the plankton of the coastal waters.

A brief discussion of hydrographical conditions and a section on the importance of the plankton elements as food precede the detailed descriptions of distribution. The first reminds us how sharp is the contrast between the south and west coast, which are bathed by the relatively warm and highly saline Atlantic water, and the north and east coasts, which come under the influence of the colder and less saline polar water; the two systems form the well known clockwise circulation round the island. The section on the plankton as food is summarized by a table. The phytoplankton is seen to be especially taken by smaller coelenterates, copepods, euphausians, Limacina, Cyphonautes larvae, and the early stages of fish, while older fish stages and such forms as the larger coelenterates, Sagitta, amphipods euphausians, and larval decapods live on an animal diet principally consisting of copepods.

The section on the quantity of zooplankton in general is based on measurement of settled volumes of plankton collected by horizontal surface hauls with the stramin net and vertical hauls with finer silk nets. A very

illuminating picture is gained of the succession in place and time of the plankton populations. A fairly intense production of copepods, cirripede and echinoderm larvae, euphausians, and Appendicularia, all important as fish food, is particularly evident in the waters off the south coast at the beginning of May. In June there is a general increase in numbers off all coasts, medusae being abundant and predominating in the west coast plankton, in contrast to sparser populations off the north and east coasts. Large volumes of plankton (again consisting mainly of coelenterates) are found along the north coast in July, while it is not until August that similar populations are recorded off the east coast. Throughout this season the smaller plankton elements are always more abundant off the south and west coasts.

This seasonal cycle of earlier production in the southern and western coastal waters, followed by later development off the north and east coasts, is again apparent for the majority of the individual plankton elements within varying degrees. It is particularly evident for such forms as the jellyfish *Cyanea capillata* and *Aurelia aurita*, the Cladocera, the Copepoda, the pteropod *Limacina retroversa*, and the larvae of cirripedes, decapods, polyzoa, and Echinoderms. Organisms on which this cycle is not impressed are such forms as the oceanic *Clione limacina*, the arctic *Limacina helicina*, which is common off the north and east coast, the tomopterids, which do not appear in the colder waters, and the Chaetognatha, which show no essential differences in quantitative distribution during the season.

In the summary two main points are elaborated. The first concerns the importance of the rich spring production of plankton off the south coast as a nursery area for the young of such fish as the cod, plaice, haddock, whiting, and herring. The other deals with the appearance and spread of the various plankton elements around the island as the season advances. Jespersen rightly concludes that at present it is not possible to separate the temperature effect (in that conditions only become possible for plankton production along the north and east coasts later in the season) from that of local recruitment of organisms in these areas by drift within the Irminger Current.

N. B. Marshall.

H. W. Graham and **N. Bronikovsky.** "The Genus Ceratium in the Pacific and North Atlantic Oceans." Scientific Results of Cruise VII of the "Carnegie" during 1928/1929 under Command of Capt. J. P. Ault. Carnegie Institute of Washington Publ. 565. Washington, D.C., 1944.

To the earlier reports by Nielson on the Ceratia of the South Pacific, and by Peters on those of the South Atlantic, has been added a third, dealing with the North Atlantic Ocean and much of the Pacific, and we can now see the principal features of their distribution over two of the major water masses of the world. This is important in itself, but for workers in more limited areas it is of particular value in presenting a background against which their own more intensive surveys can be seen.

So wide a field can only broadly be surveyed, and the 162 stations were spread over the period May 1928 to November 1929, terminating with the sad explosion at Apia. The report was completed in 1938, but was not published until 1944. Samples were collected by means of nets and pumps, mainly between 0 and 100 metres depth.

The authors, on the present evidence, have divided the area into five regions — two Atlantic and three Pacific. Each of the oceans provided a tropical and a sub-polar region, and the survey also permitted the demonstration of a fifth region in the south-east Pacific. The whole illustrates the now familiar scarcity of species, and the relative abundance in numbers, in the two colder regions, with transitional zones between them and the two warmer ones. The south-east Pacific area, extending roughly from Panama to 40° S. lat. and from the South American coast westward, also showed transitional characters. Within these generalizations there were broad temperature correlations, so that the species and sub-species could be divided into 23 "intolerant", 23 "slightly tolerant" and 5 "very tolerant" tropical forms, together with 5 "cosmopolitan" forms and 5 "sub-polar". "The authors believe that there are no truly temperate oceanic species of Ceratium. The temperate latitudes are populated by tropical and cosmopolitan forms with occasional appearances of sub-polar forms" (p. 8).

Whilst such a classification implies that groups of species may be displaced by currents, the "Carnegie" samples cannot be expected to give detailed evidence of this. It is in this respect, however, that evidence from this and similar surveys has much of its value for those workers who can give detailed attention to a local flora and its periodical visitors. Here can be seen only the more obvious features, and the important point is made that currents mix both the organisms and the water in which they live, which mixing in turn influences the extent to which organisms may be transported alive. Among the Ceratia, there were practically no signs of direct salinity influence in either ocean, and only the general effects of temperature noted above. Nutrient salts, as shown by phosphates, provided only the generalized relationship of few species with abundant nutrients at the surface, and more species where the phosphate values were small; even this provided no critical values common to the whole area, and at most the simple relationship was a relative one. To a large extent, phosphates and water temperature are inversely related, and it is common for several "causative" factors to tend to change together. It is thought possible that distribution may be partly determined by environmental factors associated with the upwelling of rich, cool waters. For instance, the upwelling waters associated with the Humboldt Current in the south-east Pacific appear to limit the distribution of certain Ceratia. This leads the authors to N i e l s o n's earlier suggestion regarding the possible influence of metabolic by-products on the distribution of Ceratia, and they introduce the possibility that some of the more stable metabolites may be richer in upwelling waters than elsewhere in the oceans. It is also suggested that N i e l s o n's hypothetical metabolites may be of plant origin, comparison being made with H a r d y's theory of "Animal Exclusion".

The data presented here, together with earlier work, are used in comparing the populations of the Pacific and Atlantic waters. Whilst no Atlantic species were found to be absent from the Pacific, several tropical species were peculiar to the Pacific, although there are no known environmental differences between the two oceans. The northern link between them, *via* the Arctic Ocean, is an obvious barrier to tropical forms and it is suggested that the cold water south of South America may also constitute a barrier for those tending to flow from the South Pacific into the Atlantic. Such a barrier would not be paralleled between the Atlantic, Indian, and Pacific Oceans. Again, although present in the North Atlantic, there are no northern forms of *Ceratium furca* in the North Pacific, although the "warm" forms are

common to both oceans; similarly there are no cold-water forms of *C. macroceros* in the North Pacific. On the other hand, there is a sub-species *pacificum* of *C. pentagonum* in the North Pacific and none in the North Atlantic. It thus appears that a northern barrier exists between these oceans for some of the sub-polar Ceratia as well as for some tropical ones.

Throughout the report there is a careful comparison with earlier work and, apart from details of specific interpretation, general agreement is found. This is particularly true of the vertical distribution of the Ceratia. The interesting point is made that none of the surface-living forms were characterized by expansion of the arms, although this is common in shade forms such as *C. platycorne*. The common assumption that surface-expansion is an aid to flotation is, therefore, criticized; it is seen rather as an aid to photosynthesis in subdued light. Again, of nearly 30 designated as shade forms (but for the uncertain instances of *C. horridum* and *C. arcticum*) none are cold-water forms.

All the species and many of their varieties are illustrated, and their distributions charted and discussed in some detail. In particular, the authors were unable to make the usual separation between *C. lineatum* and *C. minutum*, and they found it necessary to include *C. arcticum* and *C. longipes* as one species under the first name, the second being considered a variety. Whilst they found the centre of abundance of var. *arcticum* in cold waters, "isolated specimens find their way into the heart of the tropics"; yet they were never at the surface in such warm waters, although still at relatively high temperatures. The slight indication that *C. arcticum* may be a shade form is associated with the possibility that it may be adapted for life under the ice.

C. E. Lucas.

George L. Clarke. "Comparative Richness of Zooplankton in Coastal and Offshore Areas of the Atlantic." Biol. Bull. Vol. **77**, No. 2, pp. 226—255. Cambridge, Mass., 1940.

The author studies the broad changes in the richness and composition of the plankton between Long Island and Bermuda in a series of observations between October 1937 and June 1939. These sampled the *coastal water* above the 200 fathom line, the *slope water* over the edge of the continental shelf, and included a single station well removed in the *Sargasso Sea*. The coastal water had salinities of 31—34 $^0/_{00}$ with temperatures varying between 4° C. in winter and 23° C. above and 8° C. below the thermocline in summer, while in the Sargasso Sea the more stable conditions of the Gulf Stream provided salinities above 36 $^0/_{00}$ and surface temperatures varying between 19° C. and 27° C. The slope water was intermediate between these extremes.

In analysis the displacement volume of each catch was taken, as well as that of the "more nutritive" or "crustacean plankton" after the sagittas, salps, and coelenterates had been removed. Two copepod species, *Calanus finmarchicus* and *Centropages typicus*, were selected for detailed analysis.

The coastal water proved more productive than the offshore waters. Summing all the samples, the average volume in the coastal water was four times that in the slope water, which in turn was four times that in the Sargasso Sea. However, these differences resulted from the heavy summer catches rather than the winter ones, which were of the same order in the three areas. The ratio in volume of summer to winter catches was approximately thirty to one in the coastal water and ten to one in the slope water

while there was no significant change in the Sargasso Sea. A similar relationship existed for the "crustacean plankton" although the differences were less marked. There was some diurnal migration of the "crustacean plankton" but over the whole period the plankton was evenly distributed above and below the mid-depth in the coastal and slope waters while in the Sargasso Sea numbers fell off below 100 metres. There was evidence that in spite of unusual concentrations of salps, the plankton as a whole was less abundant than in previous years.

The detailed information for *Calanus* and *Centropages* showed that both were restricted to the coast. Their most successful seasons were the spring and late summer or autumn respectively, as has been found in the eastern Atlantic. There was only evidence of two generations of *Calanus* in the year, but one feels that more detailed data are required to be confident that the third breeding period consistently found on the European side did not in fact occur here.

We may be grateful to Dr. Clarke for drawing our attention once again to the danger of putting too much reliance on a single net-haul. He found that stations only ten to fifteen miles apart could give variations of the order of ten times in volume and very different ideas of the dominant planktonts. Such variations, as he points out, are far greater than need be expected from random sampling and must show real and significant patchiness in space and time. Yet frequently in plankton work a single sample is assumed to be typical of a water mass and detailed conclusions are based on such an assumption. Dr. Clarke calls for closer networks of stations where possible and the maximum smoothing of results by the combination or averaging of adjacent hauls.

It is to be hoped that there will be opportunity to continue and extend this survey; the Gulf Stream has become such a well understood body of water that this area is ideal for the study of the interrelationship between oceanic and coastal plankton.

K. M. R.

P. Jespersen. "Investigations on the food of the herring and the macroplankton in the waters round the Faroes." Medd. fra Komm. for Danmarks Fisk.- og Havunders., Ser. Plankton, Bd. **3**, No. 7. Copenhagen, 1944.

The investigations were carried out mainly in the open waters around the Faroes and Shetland islands in the summers of 1936 and 1937.

The herring caught around the Faroes consist of one spring-spawning and one autumn-spawning race. In 1936 mainly the latter were caught, while in 1937 mainly spring-spawners were taken. The two races of herring were defined on the basis of differences in development of the gonads and of the length distribution. In the summer of 1936 the length distribution formed a bimodal curve with maxima at 28—30 cm. and 33—35 cm. the average being 30 cm.; in 1937 only one maximum at 33—35 cm. was found. The two races were also distinguishable in racial investigations and age determinations carried out by Dr. Wood in Aberdeen in herring from the same seasons and areas.

The herring caught around the Shetlands in 1937 were mainly unripe and smaller (average 27·5 cm.) than the Faroe herring.

The stomach contents of the herring were examined by the author both

qualitatively and quantitatively (by measuring the volume after settlement). Owing to their dissolved condition it proved impossible to make accurate counts of the food organisms found in the stomach contents. In order to get an approximate impression of the importance of the different species the author used the frequency symbols *cc* to *rr* and gave them arbitrary numerical values.

The herring caught in the summer of 1936 was expected to spawn in the autumn. Only 12 % of the individuals had food in the stomach, consisting of copepods, euphausiids, and *Ammodytes*. In the summer of 1937 the herring were feeding much more actively, probably because they were spring spawners and, as spents, in great need of food.

The volume of the stomach contents was measured by settlement and varied in the Faroe herring in 1937 from 0·5 to 22 c.c., with an average of 7·37 c.c. The food consisted mainly of copepods, *Calanus finmarchicus* being most numerous. In addition, some euphausiids and hyperids were found.

In the Shetland herring the stomach contents volume was on an average only 0·78 c.c. and very few of the food organisms could be indentified. The most important species were *Calanus finmarchicus*, *Pseudocalanus minutus*, *Temora longicornis*, and *Metridia lucens*, but many other organisms were represented in the stomach contents, e.g., cladocerans, decapod larvae, mysids, amphipods, and *Limacina*.

Zooplankton was collected simultaneously with the investigations on the stomach contents of the herring. The samples were taken by 15-minute horizontal hauls with a stramin net just below the surface. This method of sampling is not very reliable, for neither quantitative nor qualitative study, as the author is aware. Only the larger organisms were caught, the smallest organisms commonly captured being of the order of size of copepodite stage IV of *Calanus finmarchicus*. The hauls were made by both day and night and only those taken between 19,00 and 22,00 hours were taken into account, as yielding the greatest catches.

The volumes were measured after settlement.

The copepods always formed the bulk of the catches. As the hauls were made in two different years and within a comparatively short space of time, there was a great difference between the catches of 1936 and 1937 in Faroe waters, though there are common features. *Calanus finmarchicus* was always the most common copepod, and the surface catches were as a rule made outside the 200-metre line.

The author deals with the different species of organisms taken in the hauls and to some extent, with their distribution in the surface layers by day and night.

In Shetland waters only 6 hauls were made in summer of 1937 in a period of 11 days. The plankton volumes were not essentially different from those taken in Faroe waters, but although *Calanus finmarchicus* was the dominant species, numerous other organisms were present, both copepods and larvae of bottom animals, which were not found in the surface hauls in Faroe waters.

The author is naturally very careful in comparing the plankton catches with the stomach contents of the herring. Nevertheless, there seems to be quite good agreement between the composition of the macroplankton and stomach contents of the summer herring in Faroe and Shetland waters. *Calanus finmarchicus* must be regarded as the most important food organism in both waters.

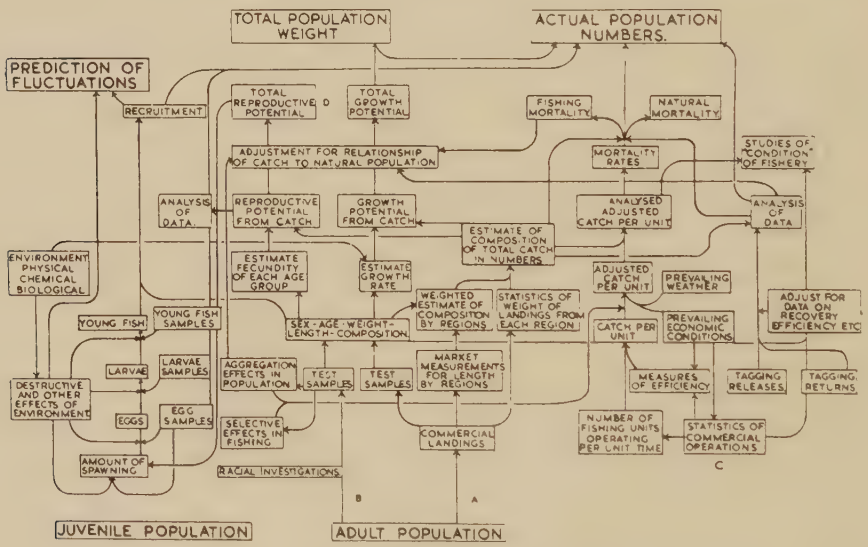
The reviewer is of the opinion that although surface hauls on single occasions may give some information as to the quantity of plankton, investigations exclusively based on surface hauls will always prove unsatisfactory for both qualitative and quantitative examined.

The most important results of the investigations are that in a limited area there may be great variations in the quantity of food in the stomachs of the herring, the variations probably being correlated both with the quantity of macroplankton present and with the developmental stage of the herring gonads.

K. F. Wiborg.

G. L. Kesteven. "A Procedure of Investigation in Fisheries Biology." Commonwealth of Australia, C. S. I. R. Bull. 194. Melbourne, 1946.

Everyone must be grateful to a worker who takes a large subject and describes it exhaustively in the minimum number of words. Mr. Kesteven does this service for fishery research, and, although I have searched his



account for omissions, I can only complain of one, that the use of the census of eggs in the census of adults is insufficiently stressed in the text. In general, it is fair to say that the paper is an exact formulation — without wasted words, and without ambiguity — of our universe, in all its ramifications, and with the relations of every part of our programme correctly, I think, defined; not exactly a child's guide to research, because the reader needs a background of experience to understand it, but certainly a reliable guide for directors in their moments of weakness.

Mr. Kesteven has also made some fascinating pictures, especially his Fig. 5, reproduced here. Data, with points of entry A, B, and C, are shown at the base, leading to conclusions at the top, *via* the various stages named, which may be supplementary data or may be methods.

Having thus, I hope, conveyed the quality of this excellent paper, I must

add that I do not believe in it except as a valuable but temporary stock-taking. The formulation is built on past discoveries, which were made by men whose vision of the subject transcended that of their fellows, as this integration transcends one that could have been formulated in 1900, or even in 1920. Like statistics, Mr. Kesteven's integration is a valuable description of the past, but can be no more than a stepping stone to the future. I write this because there is some danger that the conception shown in the diagram might be mistaken for a framework, when it might very easily cramp some extraordinary thinking or observing, for the sake of a greater "degree of coordination and planning." At present, Mr. Kesteven's looks like a formulation for all time; I do not doubt that he would join me in hoping that it will look inadequate in 20 years' time.

Michael Graham.

Å. Vedel Tåning. "Naturforskeren Johannes Schmidt, hans Liv og Ekspeditioner skildret af Venner og Medarbejdere." Gyldendalske Boghandel, Nordisk Forlag, København 1947.

On the day our esteemed friend Johs. Schmidt would have reached his 70th birthday, viz., 2. January 1947, a book, in popular style, reviewing his life and works, was published in honour of the man whom we all knew so well and who passed away fourteen years ago.

The various chapters, written by a whole array of those who knew Schmidt so well and participitated in his studies in his laboratory and on his many cruises, describe the life and the merits of the man known first and foremost by the general public as the great discoverer of the propagation of the eels all over the world. Of course this principal topic is amply discussed in connexion with Schmidt's many expeditions; the gradual evolution of Schmidt's view, his search for eel larvae along the Atlantic Slope, his voyages to the Mediterranean, his gradual extension of research into the Atlantic, and the help of Danish merchant vessels on their regular routes, the exploration of West-Indian waters and the Sargasso Sea, and finally the location of the part of the Atlantic where propagation takes place; then the larger expeditions in the Atlantic of 1921—22, and at last the crowning of it all — the circumnavigation of the globe and the researches in the Indo-Pacific. We are all more or less familiar with these various researches, and we are aware of the series of reports on the many pelagic animals obtained methodically on the expeditions.

But in other chapters we are also reminded of Schmidt's researches on bacteria, his first visit in his youth (with Th. Mortensen) to Siam, where his interest was chiefly centred on botanical investigations, resulting in his "Flora of Koh Chang"; his first introduction into marine biology by Dr. C. G. Joh. Petersen; his cruises to Iceland and his very useful studies on the spawning places and the development of Gadidae in the North Atlantic, in those far-off pioneer days, when our International Council was still in its infancy. His unremitting industry, his large experience and his forceful and kindly personality made Schmidt a prominent figure at our meetings, and the Committee of the Atlantic Slope, of which he was appointed Chairman at its beginning, owes him very much. In the course of his cruises he became, as a consequence of his methodical sampling of material, also a hydrographer, and our knowledge, for example, of the currents and the interchange of waters off and in the Straits of Gibraltar is largely due to him.

Then there are his laboratory studies in the Carlsberg Laboratory. We are told about Schmidt's experiments with plants, his racial investigations, his crossing experiments and genetic work. He was always busy, always full of projects, and so far as material and financial aid are concerned he was fortunate in being able to put his ideas into practice. The Carlsberg Foundation was a very great help, and the Øst-Asiatiske Company in Copenhagen aided appreciably by putting vessels at Schmidt's disposal.

Science owes a great debt of gratitude to a man whose endurance and ever-deepening insight assisted him in his self-imposed and many-sided tasks. Thirty-five years of vigorous scientific activity Schmidt devoted to work with which we are all more or less connected; and in many subjects we honour him as a pioneer with an open eye to practical possibilities. Looking back we marvel at his versatility and we rejoice in the scientific matter, material as well as theoretical, which is his bequest to Mankind.

The book is profusely illustrated with photographs, figures of marine organisms and diagrams, and it possesses an attractive cover.

J. J. Tesch.

Current Bibliography.

Prepared by the Editor.

NOTE. The scope of the Bibliography is limited in the main to the area covered by the Council's activities, but there are included papers of general interest relating to other areas in North Temperate and Arctic regions and exceptionally elsewhere. Limnological references are not as a rule given, but papers relating to brackish waters and to salmon and freshwater fish studied by the Council are included.

Subscribers and those on the distribution list will receive regularly upon application to the General Secretary copies of the Bibliography printed on one side of the page only, for use in making up card indices.

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